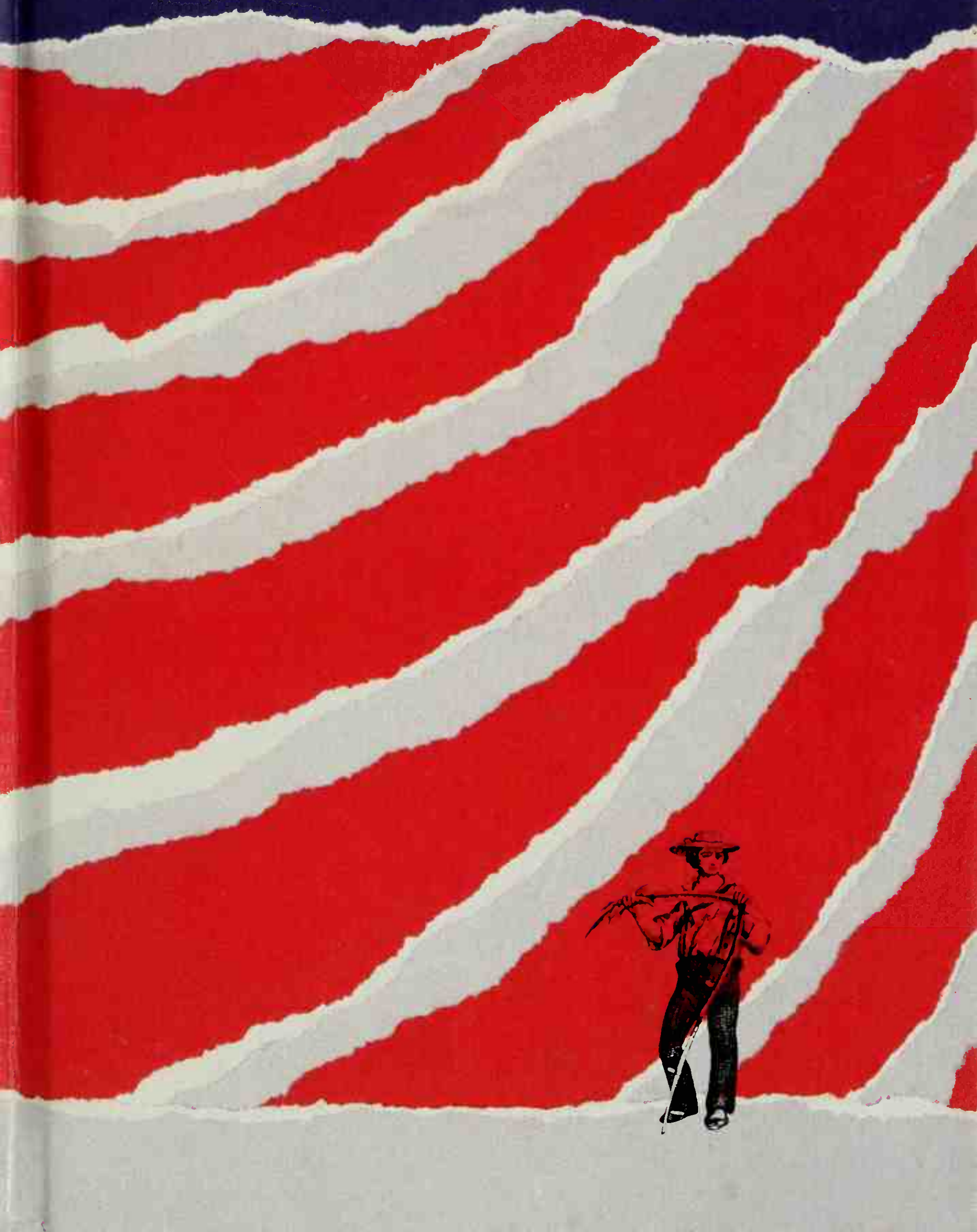
Our American Land

1987 Yearbook of Agriculture



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Our American Land

1987 Yearbook of Agriculture

Foreword

Land ownership has been a central force behind the growth of America's economic and political institutions from the first moment settlers stepped upon this nation's shores.

As every student learns most land in Europe was owned and controlled by aristocrats. With the promise of cheap, abundant land, people from all walks of life migrated to the new world.

By the time our Constitution was signed 200 years ago, about 90 percent of the people lived and worked on farms and most owned their land. Some historians argue that our very form of democratic government grew out of the economic and political problems which confronted those farmers.

Unfortunately, some settlers cared little for preserving their land because it was easier to carve out new farms than to try to restore worn out fields. Farmers spread out across the Nation in search of new land, leaving behind patchworks of exhausted cropland, virgin woodland and cultivated fields.

Not all Americans followed such practices. Men like George Washington, Thomas Jefferson and Benjamin Franklin were concerned about the care of the soil almost as much as the development of government.

Information about agricultural practices began appearing in public print. Jared Eliot of Connecticut, one of the earliest students of soil science and agriculture in general, published an influential series of "Essays Upon Field Husbandry in New England" between 1749 and 1759.

A little over a hundred years later, on May 15, 1862, President Abraham Lincoln signed legislation creating the U.S. Department of Agriculture, ". . . to acquire and diffuse among the people of the United States useful information on subjects connected with agriculture in the most general and comprehensive sense of that word. . ."

Five days later, Lincoln signed the Homestead Act, which gave government land to pioneers, free, after they farmed it five years. That Act franchised private land ownership to those who had the energy, ambition and courage to transform a frontier into the bedrock of our modern day agriculture.

Six weeks later, Lincoln signed the Morrill Act, creating a network of land-grant colleges in every state. Agricultural training was promoted to the level of a scientific endeavor, bringing a college education within reach of the sons and daughters of "ordinary citizens." The marriage between agricultural research and the wise stewardship of our land was thereby joined. Our greatest advancements in conserving land and water resources have come in this century. In 1935, creation of the Soil Conservation Service and the legislation establishing conservation districts in every state laid the basic groundwork for the successful conservation program we have today.

Despite that progress, much remains to be done. We still have a lot to learn about the complex relationship between our rural and urban areas and how our land and water resources are utilized. That challenge is what this book is about.

Nothing in this country is more precious than our soil, water, animal and plant resources. We must ensure that future generations have the opportunity to feed, clothe and house themselves.

America's land can be fragile or enduring. . . vastly productive or utterly barren. . . beautiful or despoiled. It is shaped by the life it sustains for better or worse. The choices are ours. It's a time for us to take pride in America and make it great.

Richard E. Lyng
Secretary of Agriculture

Preface

Land and history often are inseparable subjects and they are treated as such in this book.

The historical theme is particularly appropriate because 1987 is the year for Americans to celebrate the 200th anniversary of the Constitution of the United States. The Constitution was not intended to address land issues directly. It nevertheless greatly influenced the national landscape, its development, its preservation, and its continuing promise.

Primarily, however, this is a book about land, mainly how it should be used and maintained. The American conservation ethic is discussed and past and ongoing national resource management policies are reviewed. It is about a land still in transition between wilderness and its destiny as a Nation.

A reader, on finishing "Our American Land," may conclude that, thanks to technological progress, Americans are managing land resources better than ever. While in many ways this is true, the book cites numerous instances in which old ideas, neglected for decades, have become credible and useful again because today we know enough to truly appreciate them.

In the final analysis the reader may find reassurance among these pages. The land is the embodiment of our heritage. It provides a physical continuity. Its influence on our lives and the lives of generations yet unborn awes and perhaps frightens us just a little.

Land is, after all, like air and water, one of the basics of life itself. Human beings, beginning with their pursuit of agriculture, have unalterably changed it and in doing so become its masters and managers. Humanity ultimately is responsible for the results.

My respect and gratitude go to the members and associates of the 1987 Yearbook Executive Committee, who guided the selection of the subjects and solicited the participation of distinguished authors. The authors overcame difficulties in deadlines and communications to produce worthy work. I also commend the immediate staff of the Yearbook who watched quality, budget, and the production schedule with even-handed care. Insofar as possible, these individuals are identified in the credits and bylines.

William Whyte, *Yearbook Editor*

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The Land and the Constitution

Part I

Agriculture's Influence on the Constitution

Douglas E. Bowers, head,
Agricultural and Rural History Section,
Economic Research Service

When the Constitution was created, America was a Nation of farmers. Ninety percent of the people lived and worked on farms, most owning their own land. These farmers were, themselves, divided on the issues that led to the Constitution. Farming interests, nevertheless, shaped the issues debated by the delegates to the Constitutional Convention in Philadelphia during the summer of 1787. They also influenced the final outcome.

While the Convention did not write an agrarian Constitution, the document was flexible enough to weather the shift from agrarian to urban society with little change.

Seedbed for Democracy

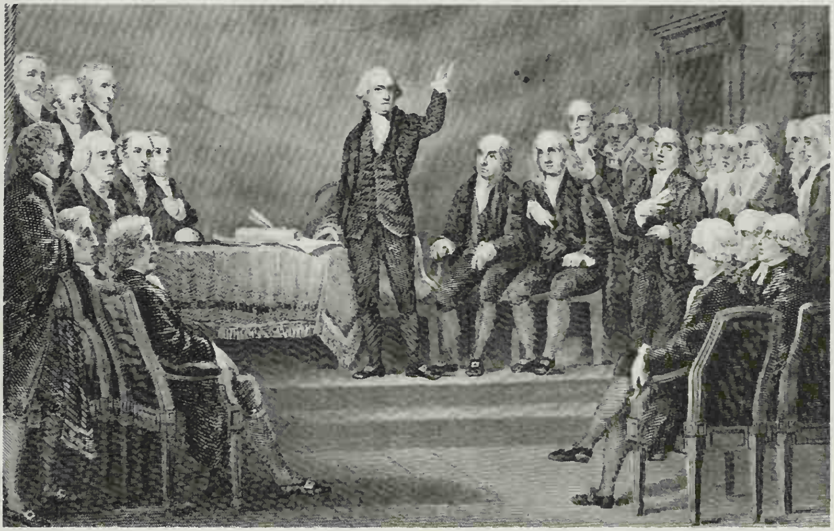
In a broad sense, our democratic form of government might not have been achieved without input from landowning farmers. Eighteenth-century European society was tied to an aristocracy in which land was held by relatively few. The middle class was small while great masses were poor and illiterate. In England, the wealthiest country in Europe, half its people lived in poverty.

America stood out in contrast. Land was cheap and readily available. America became a land of small farmers. This was true throughout the country—in New England with its village farm communities, in the breadbasket of the mid-Atlantic States, and in the South, where many small farms coexisted with a few large plantations.

As a result, most white Americans, at least, enjoyed not only a high standard of living, but more individual political and economic responsibility than did Europeans. Despite property qualifications for voting and holding office in many States, participation in elections was widespread. This sense of personal responsibility encouraged citizens of the United States to achieve one of the highest literacy rates in the world.

Some of the founding fathers made an even more direct connection between ownership of agricultural land and democratic institutions. To Madison and Jefferson (who was not at the convention but whose ideas had a great impact there), future danger lay in the growth of cities.

America's great strength, they



George Washington presided at the Constitutional Convention in 1787 when 90 percent of Americans lived and worked on farms. (Library of Congress, LC-USZ62-12343)

believed, was its independent yeoman farmers, who could not be swayed like the mobs of Europe. As Jefferson put it, "Those who labor in the earth are the chosen people of God." These ideas were probably shared by most American farmers.

Farmers at the Convention

Of the 55 delegates attending the Constitutional Convention, 22 derived at least half their income from agriculture. They were not typical American farmers. Most of them owned large farms or plantations and were considered upper class. In addition, a number of delegates owned country estates or had other agricultural interests; several grew up on farms before becoming lawyers or merchants; and a few were land speculators who sold land to Western farmers.

A Nation of Land

Land was an important reason for writing the Constitution. Farmers had been pushing across the Appalachians since before the Revolution, attracted by the rich and inexpensive lands. But these lands were in danger of breaking off from the United States.

Ordinances by Congress in 1785 and 1787 guaranteed that the Western lands ceded by coastal States would be available for purchase from the national government and that the new States formed there would enter the Union on the same basis as older States. But the future of farmers who had settled in the West was jeopardized by the feeble national government that the Articles of Confederation had established.

Both Britain and Spain encroached on Western lands with impunity. Spain's threat was the worst, for that government often denied American farmers access to the port of New Orleans (essential for Western shipping) and intrigued with settlers in the new territories to secede from the United States.

Many Americans hoped that a stronger government would eliminate foreign meddling in American affairs and make Western lands secure for Eastern settlers. The new Constitution created such a government and strictly prohibited States from negotiating with foreign countries.

The Trade Incentive

Trade was likewise a pressing issue, both for farmers and urban merchants (who were also prominent at the Convention). Like most nations emerging from colonial status, the United States produced mainly raw materials and had to import most of its manufactured goods.

The fertile, new lands of America yielded surpluses from the beginning for shipment overseas. The country already depended on agricultural exports for much of its national wealth. American ships carried tobacco, rice, naval stores, indigo, wheat, and flour principally to Europe and the Caribbean.

In 1787 this trade was precarious. The weak Federal Government could not control commerce or even levy an effective tariff or internal tax. After the Revolution the British cut back on American exports and severely restricted trade with the lucrative markets of the Caribbean. So one compelling reason for writing the Constitution was to create a strong, unified government that was capable of winning trade concessions and dealing with other nations on an equal basis.

Trade Barriers. Another trade issue was between the States themselves. Under the Confederation, the States were free to set up individual trade barriers on foreign shipping and even between each other. This resulted in a confusing array of tariffs and other restrictions that threatened to thwart agricultural trade.

Thus, the new Constitution took away State jurisdiction over interstate trade and also forbade tariffs on exports. This provision satisfied Southerners, worried that giving Congress the power to decide trade matters by a simple majority might hurt exports and result in high tariffs on imported goods.

New American Money. An agricultural issue that preceded the Constitution was farm credit. Farmers always had difficulty obtaining credit to buy land, and so many colonies made it a practice to loan money on real estate to farmers directly by issuing paper money. Hard times after the Revolution (due in part to the loss of trade) caused several of the new States to issue so much paper money that it became seriously depreciated. This, in turn, led to general price inflation, benefiting farmers but hurting creditors.

Thomas Jefferson's ideas about the importance of farmers to the success of a democratic government greatly influenced the writing of the Constitution. (Library of Congress)

States unresponsive to farmers' demands for easy credit faced political upheaval.

This situation led to Shays' Rebellion in Massachusetts, during which angry farmers and former soldiers prevented local courts from foreclosing on farmers and released debtors from prison. Many people, particularly merchants and creditors, wanted a new national government that would restrict the right of States to issue money and, in general, protect property rights better. These ideas were included in provisions outlawing State coinage and prohibiting States from impairing contracts.

The Two Agricultures

Further conflict developed at the Convention between two different types of agriculture, namely the plantation system with slavery that many Southern farmers used and the farming (and other economic activity) without slaves that characterized the Northern States. Southern planters wanted slaves counted in the census for representation in Congress but not for purposes of taxation. Some of them also opposed restrictions on importing more slaves. In a compromise with Northern delegates, the Constitution counted three-fifths of the slaves for both taxes and representation and barred interference with the slave trade for 20 years.

Ratifying the Constitution

The Constitution was written by individuals who held distinctly different visions of America's future. This may be oversimplified, but delegates from cities, especially those who agreed with Hamilton, envisioned a nation with a strong central government and a diversified economy that balanced manufacturing, commerce, and agriculture. Rural delegates in the Madisonian camp feared the growth of industry and wanted to preserve the agrarian character of American society. Both sides saw advantages for themselves in the new Constitution.

Hamilton believed the new government would be strong enough to preserve order and encourage industry through a tariff on imported goods, a central banking system, and sound credit policies. He argued that the growth of industry, far from hurting agriculture, would provide markets for farm products.

Madisonians, on the other hand, looked to government to open new markets overseas, secure Western lands, improve internal transportation, and protect the rights of States and individuals. In other words, they believed the Constitution would significantly aid agriculture. Both sides agreed that the new Constitution was necessary to prevent the republican experiment from falling apart.

Not all farmers shared the optimism that Jefferson and Madison had about the Constitution, however. Farmers as a whole were ambivalent on the issue, and it was largely opposition from farmers that made it so difficult to get the Constitution ratified. Votes were close in several States.

While the requisite number had approved in time for elections in 1788, the last State did not join until 1790. Antifederalists, as they were called, objected to the idea of strong government, which might trample on individual rights. They also believed the Constitution would benefit mainly cities and encourage speculation and corruption. On the other hand, the arguments of men like Madison and the presence of so many rural delegates in the Constitutional Convention no doubt helped convince many farmers to support the new government.

In any event, the debate over the meaning of the Constitution did not die with its ratification but dominated politics for the next two decades. By 1815 the supporters of Jefferson and Madison, who had become the majority party, came to accept much of Hamilton's program without losing faith in agrarian values. Those values have been a part of American politics ever since.

Making New States and Establishing the Public Domain

Sally K. Fairfax, professor of
natural resources law and policy,
University of California, Berkeley

During most of the 19th century, Congressional policy on the growing public domain was to use it to form and settle new States. That the lands would be fully disposed of was never doubted. Debate focused on what the new States would gain in return for waiving future interest in and the opportunity to tax the public lands pending disposition.

Bargaining Among States

The original competition between the large and small colonies was soon replaced by bargaining among old and new States. The new States pushed for cessions of all the Federal lands within their boundaries, claiming them as a Constitutional prerequisite for the equality promised as a condition of statehood. Failing that, they bargained for grants of land and dollars, for speedy land surveys and sales, and for concessions to "squatters" on the public domain.

The old States took the position that the public domain existed only because of the "common sword, blood, and purse" of the original 13 colonies. Hence, they challenged the constitutionality of statutes under which common lands were granted to benefit particular States.

Shifting State Coalitions

At first the political clock ran in favor of the new States: as more and more western States joined the Union, the position of the old States eroded and Congress became more and more generous with grants of land to new States. Then, as the 19th century closed, many of the early new States began to support the position of the old States and joined with the original 13 to assure that the public lands would serve the common benefit of all the States through permanent Federal land reservations.

Preemption and Distribution Act of 1841

Congress faced a quandary in deciding what to do with the budget surplus accumulated between 1830-1840 from land sales and tariff revenues. Old States argued for distribution of the funds to all States, a reflection of their common benefit position. The new States wanted some of the same, plus benefits for homesteaders.

The budget surpluses were

divided—63 percent to the old States, causing them to relax their objections to land grants to new States. The new States then received 10 percent bonuses on receipts from public land sales. Additional grants of 500,000 acres were awarded retroactively to a growing group of the earliest new States (Louisiana, Michigan, Mississippi, and Missouri).

In addition, squatters on unsurveyed, Federal lands were granted "prospective preemption" which assured that, when the Federal Government did survey and auction the land, they would be allowed to bid the minimum allowable price without competition.

Common Benefits

As new States matured, their public lands policy preferences became more and more like the old States. Then, traditional insistence on common benefits was expressed in the 20th century by a growing Congressional commitment to land reservations.

An 1891 provision of a General Land Law revision established Presidential general authority to make reservations from the public domain to protect the forest cover, hence the watersheds. This Congressional action signaled a major change in Congress' approach to public lands. Although that authority was redefined nearly out of existence in 1907, most western National Forest lands were reserved by that time, and the idea of permanent Federal ownership of large areas of land was beginning to take hold. Hence there emerged a group of western States where the public domain would not be disposed of and where approximately 35-90 percent of the land would be subject to Federal jurisdiction.

These reservations constitute a continuation of ancient bargains: the old States and the older new States combined to achieve common benefits from common lands by reserving land for permanent Federal ownership, and later Federal management. And, continuing the pattern clearly visible in the 1841 Preemption and Distribution Act, the western States insisted successfully that they should be compensated for the loss of control and authority over their land with a share of the revenues produced by management programs.

National Forest Revenue Sharing

The concept of revenue sharing made its debut in connection with the extensive, continually expanding, forest reservations. It is difficult to be specific about the precise purpose that Congress had in mind when it began, in 1906, to share forest reservation revenues with the States.

Doubts about the purposes of the reserves—whether they were to preserve watersheds or be open to silviculture—were unresolved. The appropriateness of any fee for water, grazing, or for timber use was an open question. Congress was undecided whether the reserves should pay their own way, make money for the Treasury, or be supported by the general fund.

Congress adopted the National Forest revenue sharing program slowly, over 3 years, in three separate riders on annual appropriations bills.

Taylor Grazing Act

The 1934 Taylor Grazing Act broke with the pattern of western States bargaining for revenues in return for acquiescing in eastern States' efforts to achieve common benefits through retention and control over public domain lands. Although 142 million acres were withdrawn from entry and established as grazing districts, only 12.5 percent of receipts from grazing districts go to the States.

1976: Old Patterns and New Events

Public land policy lurched decisively towards Federal planning in the Bicentennial Year of 1976. The Federal Land Policy and Management Act ended the "pending final disposition" cloud over the grazing districts, formally established the Bureau of Land Management, and sharply curtailed local control over public lands grazing. The public domain lands were, symbolically, renamed "Federal lands." Although the Taylor Grazing Act was not repealed, it was enmeshed in a complex web of multiple use planning and management requirements designed to achieve national goals on the Federal lands.

The National Forest Management Act, the Federal Land Policy and Management Act, the Federal Coal Lease Amendments Act, the Surface Mine Control and Reclamation Act as well as amendments to the air and water quality acts were all being debated on the Hill. All this promised to significantly increase regulation of Federal lands in western States. These assertions of Federal control were accompanied by expansion of the western States' share revenues produced by such lands.

The National Forest Management Act shifted the return to counties from 25 percent of net receipts to 25 percent of gross receipts.

Future Trends

These 1976 programs are notable for dramatically increasing Federal control over Federal lands.

The previous practices of paying the western States for acquiescence in national policies may have reached political as well as practical limits. Given the amount of revenue that the States are presently allocated under Federal resource management programs, there are few places where the States could increase their shares. The Federal Administration, in turn, burdened by debt, constantly proposes ways to reduce resource revenue sharing.

Given that debit, the eastern States' assessment of the value of western acquiescence in common benefit programs may decline. Instead of using scarce Federal revenues to fund previous commitments to western States, eastern States may become increasingly willing to experiment with programs to share management authority with western States and traditional user groups.

How the Constitution Shaped Our Agricultural Institutions

Don Paarlberg, professor emeritus,
Purdue University, West Lafayette, IN

William Gladstone, the great British statesman and Prime Minister, once described the American Constitution as "the most wonderful work ever struck off at a given time by the brain and the purpose of man." Certainly the American Constitution has withstood the most decisive of all tests—the test of time; the Charter drafted at Philadelphia 200 years ago is the oldest written constitution in the world.

A Flexible Instrument

The major attribute of this instrument is its flexibility, nowhere more evident than in its relation to agriculture. Written for an 18th century agrarian society totaling 4 million people, the Constitution presently serves as the basic legal document for an industrialized agriculture in a nation 60 times as large.

It began by permitting slavery (17 of the 55 delegates were slave owners) and then outlawed that institution. It first had strong emphasis on States rights and later accepted a trend toward centralized decisionmaking. It has accommodated the development of an agriculture that is the admiration of the world and, at the same time, has curbed agricultural initiatives that were not in keeping with its evolving letter and spirit.

The Constitution can be magnificently ambiguous and at the same time coldly rigorous. It is both permissive and disciplinary, a gloved hand concealing an iron fist. Flexibility has come in large degrees from interpretation. Chief Justice Charles Evan Hughes said in 1926: "The Constitution is what the Supreme Court says it is."

Constitution Favors Agriculture

Five examples of agricultural institutions that the Constitution *permits* follow:

1. It gives agricultural political strength in that each state has two senators. A majority of senatorial votes can be obtained from 26 States, most of them with strong agricultural interests, having in total only 17 percent of the American population.

Farm lobbyists call the Senate "the Upper House" not because of any superior status but because after the

Students pose during plowing at Pennsylvania State University, one of the first land-grant colleges, at about the time the Land-Grant College Act was passed in 1862. (USDA, BN-15378)

House of Representatives has voted some agricultural benefit, the Senate often "ups" it. The necessity of obtaining Senate concurrence on agricultural legislation explains in part the solicitude for agriculture that characterizes our national policies and helps shape our institutions.

2. Constitution provides strong safeguards for property rights, thereby permitting a broadly-based entrepreneurial agriculture. Land ownership and patent rights grew out of the high regard in which delegates to the Constitutional Convention held individual initiative and enterprise. These concepts reflect Jeffersonian ideas of democracy and at the same time acknowledge Hamiltonian views regarding the merits of a propertied class.

The Constitution fosters widespread ownership of land, private business, grassroots initiative, and responsibility. It gave agriculture a different start in this country from that in many Latin American countries with stronger central governments and fewer individual rights.

In some respects the Constitution embodies a counterrevolution, modifying the insurrectionary excesses of 1776. This is another manifestation of its genius.

3. Constitution accommodated the Land-Grant College System.

When Justin Morrill first offered his Land-Grant College Act, opposition was immediate, based in part on allegations of unconstitutionality. But the Constitution could not be construed so as to reject Morrill's legislation. The act was passed in 1862, to be followed in 1887 by the Hatch Act setting up the experiment stations, and in 1914 by the Smith-Lever Act providing for the Extension Service. Federally funded research, classroom teaching, and extension services came into being.

The consequences of these institutions are profound. The experiment stations produced hybrid corn and streptomycin. By the time the land-grant colleges reached their hundredth anniversary, the State universities (of which they are a part) enrolled one-fifth of all the undergraduate students in the Nation. Of the 36 then-living Nobel Prize winners in the United States, 18 had earned degrees in land-grant colleges and State universities.

The Extension Service claims to be the largest outside-the-classroom educational institution in the world. It is hard to imagine what agriculture would be like if the Constitution had prevented the development of this system.

4. Constitution permits the income tax. The Constitution originally provided for tariffs on imports but not for income taxes. The Sixteenth Amendment passed in 1913 permits the levying of a Federal income tax, opening up a vast source of revenue, mostly from nonfarm sources. Agriculture, with its many exemptions, pays little income tax, so great financial resources are available for transfer to agriculture.

The commodity programs would hardly be possible without the Federal income tax. The great growth of the Federal Government, with its resulting modification of agricultural institutions, dates from the passage of the Sixteenth Amendment.

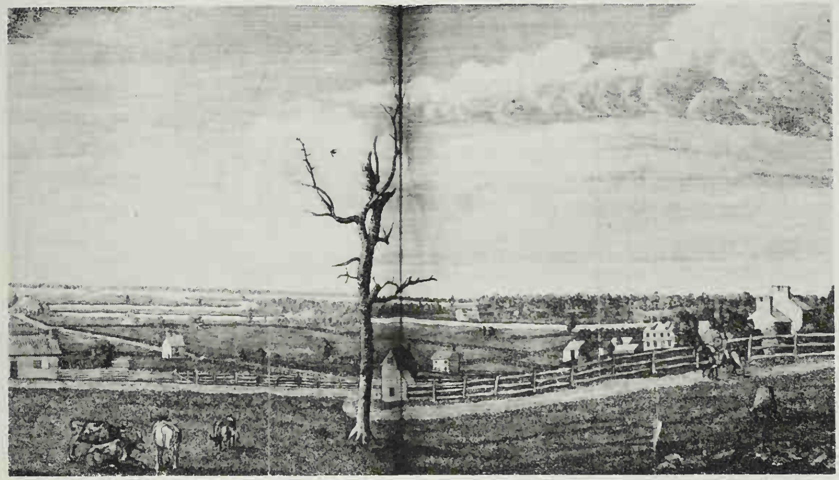
5. Government programs to regulate the price and production of farm products are permitted. This came after a long and fierce battle; the Agricultural Adjustment Act was declared unconstitutional in 1936, but within a short time a way had been found to make the basic provisions of the act constitutional. Corn, wheat, and cotton programs are the result either of a reinterpreted Constitution or an end run around it.

Constitution's Prohibitions Against Agriculture

While the Constitution *permits* the development of many agricultural institutions, it *prohibits* certain other forms. Again, five such examples follow:

1. It prohibits a State from taxing the incoming products of another State. This prohibition corrects a major flaw in the Articles of Confederation. By specifying that interstate commerce is within the province of the Federal Government, the Constitution provides for a national market in farm products, with great resulting efficiencies in agricultural production and trade.

If each State could restrict the



A 1787 pastoral farm community near Wilmington, Delaware, is shown in this woodcut. (Library of Congress, LC-USZ62-31151, from Columbian Magazine*)*

movement of farm products across its borders and should strive for self-sufficiency as do many countries in today's world, we might be trying to grow wheat in Florida and tomatoes in Kansas. The framers of the Constitution saw and averted such inefficiencies.

2. Constitution specifically prohibits export taxes. Other agricultural exporting countries, among them Argentina and Thailand, tax exports of farm products. They thereby drive down prices at the farm level and inhibit agricultural development. The United States prevented such taxes by writing, in Article I, Section 9, a prohibition against them.

3. Constitution prohibits nullification and secession. It took a terrible war, however, to win acceptance of these prohibitions. Had it been possible for a State to nullify a Federal statute or to secede from the Union, we probably would today be several nations instead of one, and the agricultural institutions in the respective mininations would be different from what they are at present.

Southern agriculture might be dominated by a small, wealthy landowning class. The Southwest might reflect the institutional forms of the Spanish agricultural system. The Midwest, with misgivings about these forms, might have developed an agricultural system of its own. Instead, having remained a single country, we have a certain unity while retaining a large degree of diversity.

4. Constitution outlawed segregation. This altered the nature of government services to agriculture and is gradually changing our agricultural institutions, providing improved opportunities, civic, social, educational, and economic, to people who formerly lacked these advantages.

To illustrate the Constitution's flexibility, in 1954, after the Supreme Court had rejected the "separate but equal" concept, a Southern Congressman commented: "It's very confusing. We change the words of the Bible without changing its meaning and we change the meaning of the Constitution without changing the words."

5. Constitution prohibits cartelized business forms. In a famous 1935 confrontation, *Schechter v. the United States,* the "sick chicken case," the Supreme Court struck down the National Industrial Recovery Act. This act had permitted industrial groups to join together, without legislative oversight, setting up codes for the conduct of their business. The overthrow of this act was a great gain for competitive enterprise, avoiding the cartel-like institutions that characterize some other countries. Farmers buy their input items from and sell their products to business firms that must adhere to a competitive pattern.

Nurture and Guardianship

One can argue at length about the wisdom of these Constitutional permissions and prohibitions. But it is not possible to contend persuasively that our agricultural institutions grew up, like Topsy, without having been born and raised. The Constitution provided nurture and guardianship. Just as a child may grow up unaware of the subtlety of parental influence, so we in agriculture may take our Constitutional heritage for granted. It is well, in this bicentennial year of the Constitution, to consider its influence on our agricultural institutions.

How Americans Got Their Farmland Before the Constitution

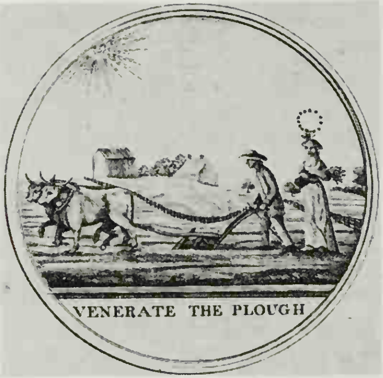
John Opie, director, Center for Technology Studies,
New Jersey Institute of Technology,
Newark, NJ

The way for a young man to get ahead in early America was on the farm. In 1768 the Governor of New Hampshire reported that "scarcely a shoemaker, a joiner, or silversmith but quits his trade, as soon as he can get able to buy a little tract of land and build a cottage in the wilderness." Eight of 10 Americans prospered by cultivating the land compared today to 1 in 50.

Jefferson and Crevecoeur heaped praise on the virtuous independent yeoman farmers working diligently on their own land. With a vast fertile wilderness to turn into a prosperous garden, agriculture seemed the wave of the future. Most young men in that day knew how to plow a straight furrow, handle a horse or ox, and butcher a pig or chicken. Farm tools were few, inexpensive, and required only reasonable skill.

Who Owned the Land?

At first, individual ownership of land did not come easily. Most colonial authorities strove to keep the land in the hands of an aristocratic elite. For example, Virginia's earliest settlers were hired hands with no access to the land. But after Virginia's infamous "starving-time," each employee received a 3-acre "garden" as incentive to remain and to attract new settlers.



This 1786 woodcut shows the predominance of agriculture to the people of the day. (Library of Congress, LC-USZ62-31153, from Columbian Magazine*)*

Now Virginians, it was reported, did a week's work in a day. Access to land by the common man became the most important road to colonial prosperity. In contrast, New York's expansion came to a standstill because the colony's land was divided up among a few powerful Dutch or English families. Pennsylvania, where farmland was available, bustled with prosperous farms and westward-moving settlement.

But when the American Revolution came, as the new United States was legally separated from England, who owned the land? Many farmers were the last to join the rebel cause because of this uncertainty about the foundation of their prosperity. But everyone would soon agree that existing landholdings—which made possible America's historic "right to farm"—would remain binding. Much later, in 1834, Chief Justice John Marshall would say "the people...may change their allegiance...but their relations to each other and their rights of property remain undisturbed."

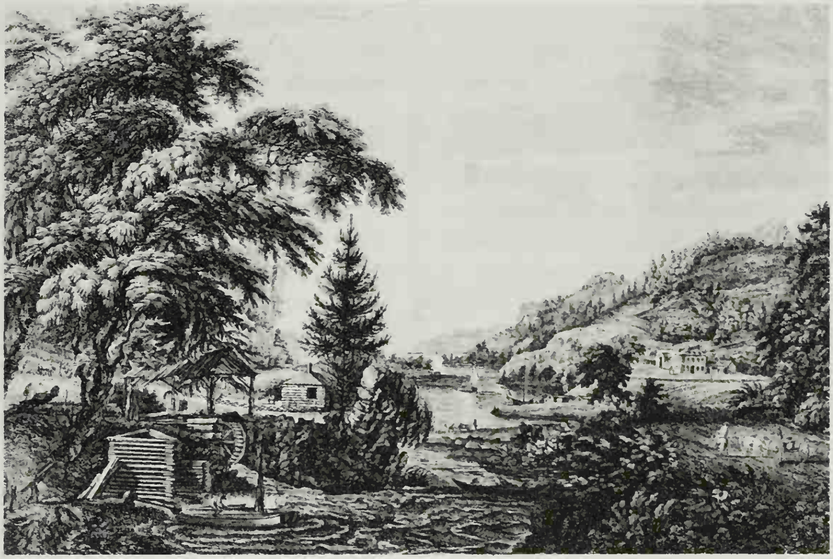
Creating the Public Domain

The new States, fearful of tyranny from any central government, carefully guarded their individual sovereign rights. They also fought bitterly over unequal and overlapping claims to unexplored and unmapped lands across the mountains. The 1783 peace treaty included the vast 237 million acres across the Ohio River. States with no western claims—New Hampshire, Rhode Island, New Jersey, Pennsylvania, Delaware, and Maryland—feared an inferior status. States with western claims—Massachusetts, Connecticut, New York, Virginia, the Carolinas, and Georgia—insisted they had fought a war to protect their land rights. All States feared Virginia since it was already the largest State and had excellent claims that would have given it half the continent.

Land Debates. One solution was to make the land west of the Pennsylvania line into a national commons or public domain. Had it not been "wrested from the common enemy by the blood and treasure of the thirteen states?" Even during the war, Maryland angrily insisted it would never ratify any new central government unless the West was held in common. Land debates threatened State armies marching against each other and the imminent breakup of the barely born nation.

To the surprise of everyone, Virginia broke the impasse, under Thomas Jefferson's egalitarian prodding, by ceding its Ohio claims to Congress on 1 March 1784. Other States followed by 1786, aside from the craftily conceived Virginia and Connecticut military reserves in the Ohio country. Maryland, barely satisfied that it would not be outstripped by the other States, reluctantly ratified the Articles of Confederation early in 1781. Nothing at all in the Articles addressed how the newly created public domain was to be managed despite its place as the new government's greatest asset. Each State retained its "private right of soil."

Orderly Settlement. The Confederation Congress immediately felt intense lobbying to sell off the public lands. It deserves enduring admiration for its attempt to avoid the confusions of land speculation and uncertain ownership already commonplace in several States. Congress instead turned to the orderly settlement pattern which had



This view of a prosperous farm settlement in Pennsylvania appeared in a 1768 issue of Scenographia Americana. *(Library of Congress, LC-USZ62-31185)*

worked for more than a century in New England: regular geometric units easily located on a plat map and sold to responsible farmers.

New England seemed dotted with the ideal national landscape: small independent farms, well-developed communities with schools and churches, centralized control of land development, and strict government regulation of speculation. That the settler bought a definite tract of land, with specific boundaries, instead of irregular, often overlapping claims, burdened with litigation, captured the admiration of Thomas Jefferson's 1784 congressional land committee.

Jefferson was soon called away to be ambassador to France, but Congress' desperate need for cash brought the passage of the Land Survey Ordinance on May 20, 1785, more than 2 years before the Constitution. The scene created is still familiar today across the western two-thirds of the United States: townships set at 6 square statute miles, each containing 36 square mile (640 acre) sections (later subdivided into the famous 160-acre "quarter section"). These were sold at public auction at a standard price of $1 an acre (later ranging from $2.50 to free land), following surveys regulated by the new office of Geographer of the United States.

The initial Seven Ranges survey began right in the middle of wilderness settlement where the Ohio River crossed from Pennsylvania into the unorganized Ohio public domain. Details of the land survey, prices, exceptions, and procedures were modified repeatedly by new acts of Congress, but the basic pattern remained unchanged until the Federal Government stopped selling public land 150 years later, in 1935. The Land Survey Ordinance of 1785 was incorporated into the Northwest Ordinance of 1787 and the new Constitution for the speedy disposal of the public domain into private hands.

A Geometric Nation. The impact of the rectangular survey cannot be overstated. By this single act, the Confederation Congress, otherwise so pitifully weak, transformed the West from a formless and dangerous wilderness into a remarkable national geometry which would continuously extend into regions still unknown and unowned. It was the powerful visible representation of the Age of Reason in America.

In a more negative light, Congress also forced on the American farmer a right-angled geometry of square and rectangular fields where the naturally curving geography of fields ought instead to have been measured by terrain, workable size, soil quality, and watercourses. Generations of American farmers complained that their survey land missed an important spring or a useful stand of trees by a few feet, or held a swamp dead center in their quarter section.

Squatters and Speculators

Unfortunately, the orderly spread of tidy small farm tracts was never more than a pious dream. For more than two decades before independence, farm families had already been unlawfully entering the wilderness west of the Alleghenies, filtering across western Pennsylvania and into eastern Ohio into a no-man's-land between hostile English, French, and Indian interests. They were the first line of "pre-emptors" or "squatters" who would embarrass the government claiming that they served the national interest by clearing the wilderness.

The British had tried to stop their meddlesome spread at the ridge of the Alleghenies with the Proclamation of 1763, one of the most useless and provocative orders in colonial history. Later, the new United States used soldiers to remove illegal settlers, but the public uproar quickly ended the skirmishes and gave the squatters a free hand on the unsurveyed and unopened public domain.

In addition, land speculation, already America's biggest industry, rose to new heights even during the Revolution and the struggle to create a new nation. Buying and selling land often guaranteed short-term profits at a breathtaking 1,000 percent. The rush to make a profit on land formed the background to the creation of the public domain, land laws, and the Constitutional Convention in the summer of 1787. The government nearly lost control of the public domain when much of it was claimed by very large private estates, leaving little land available directly to the ordinary farmer.

The Ohio Company claimed 500,000 acres along the Ohio River, the Indiana Company 1.8 million acres, and the Illinois Company 1.2 million acres. Even Daniel Boone's romanticized wanderings in Kentucky were actually quasi-secret and well-financed reconnoiterings for the arch-speculator, North Carolina's Judge Richard Henderson. Henderson's Transylvania Company eventually collapsed, and he settled with Congress for a mere 400,000 acres.

Speculators swarmed over the weak Congress and the debates at the Constitutional Convention. In July 1787, the Ohio Company's agent, Rev. Manasseh Cutler, persuaded Congress to sell a million acres at one-tenth the asking price. He immediately increased the value of the land by successfully lobbying for the Northwest Ordinance.

Most ambitious Americans speculated in land, including Benjamin Franklin, Patrick Henry, George Morgan, and Robert Morris. No one was more aggressive than George Washington, who was normally taciturn but would get visibly agitated at a good land deal. Years earlier, Washington had set a fast pace by his participation in the Grand Ohio Company's unsuccessful but impressive attempt to carve out a 20-million-acre private colony named Vandalia. Washington's personal western holdings eventually totaled 32,373 acres.

American Land Becomes Private Property

Squatters and speculators were visible manifestations of a single compelling force underlying the creation of the agricultural landscape of America. Why did the struggling Confederation Congress rush to get rid of the land? Why not keep it as the public's national treasure? But the Ordinance of 1785 had a single overweening objective: the "Western Territory...ceded by individual states to the United States," and "purchased of the Indian inhabitants," was to be "disposed."

Apparently no one argued to keep the public domain in government hands, at most rented to responsible farmers. Only Thomas Jefferson, in a hopeless cause, argued that the public land ought to be given away to virtuous, hard-working, productive citizen-farmers. Everyone else pressed to sell the public commons to private interests, and as quickly as possible.

Private Property. The strongest undercurrent in the years before the Constitution was an early American preoccupation with private property—more an undertow that pulled everything with it. Americans made certain nothing stood in the way of the protection of private property, particularly the right to acquire land and do with it as one pleased, whether to clear out a farm or to reap a handsome profit. When the Virginia governor in the 1750's intervened against runaway speculation, the House of Burgesses quoted the Royal Declarations against him, "that no man's...freehold...be taken away or harmed."

One Burgess, Richard Bland, tightly linked property to liberty in a seamless argument; both were "precious vessels whose soundness is destroyed by the least flaw and whose use is lost by the smallest hole." Later, the Declaration of Independence included the widespread complaint about property-taking "taxation without representation."

Individual license to acquire, improve, sell, trade, and speculate in land was not negotiable. It was also more than a matter of principle. With the continent's wide open spaces, financial killings were made virtually without risk. This rocklike dedication to private land ownership did not shift an inch during the upheavals of the revolutionary era.

Philosophy of Locke and Harrington. In a neat turn, the rebellious Americans quoted English philosophers John Locke and James Harrington about the inviolability of private property. Harrington defined freedom as private unconstrained ownership of land. Locke argued that the right to ownership of land was the fundamental human right of subsistence; all people must have access to land so they might not starve. Locke said, and Jefferson agreed, that farmers in particular earned the right to land because their hard labor transformed the wilderness into productive farmland. "As much land as a man tills, plants, improves, cultivates, and can use the product of, so much is his property."

New State constitutions in Virginia, Massachusetts, New Hampshire, New York, Pennsylvania, and Vermont emphasized universal "natural right" landholding. Their "right to acquire" clauses would, it was believed, ensure "happiness and safety" among free and independent men.

Constitutional Debate Avoids Land Issue

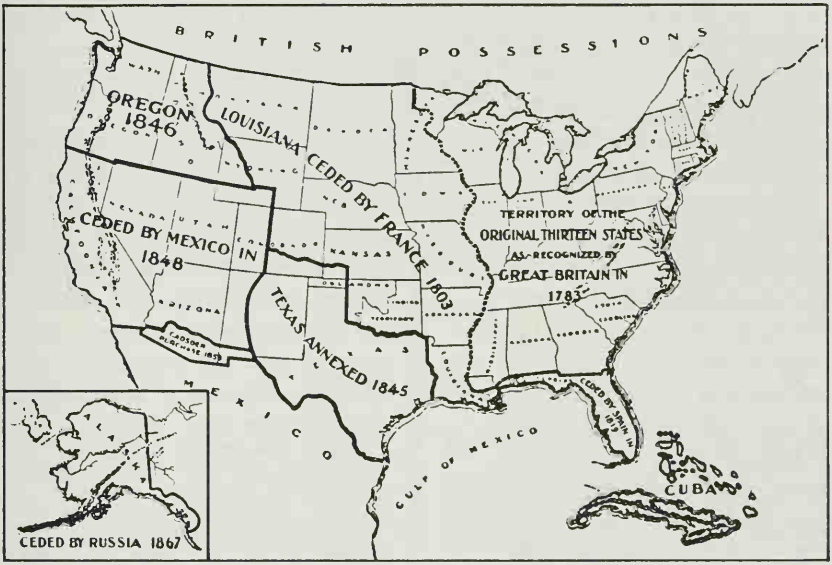
Unencumbered private access to land, and the profits it generated, was so widely accepted that debate over the future of the public domain could be carefully sidestepped at the Philadelphia Constitutional Convention in the summer of 1787. No peasants marched on Philadelphia with clubs and pitchforks to demand land reform. Already a remarkable 70 percent of freemen owned some land. American landowners were not condemned but admired and imitated. The Revolution was fought for, not against, private property.

Faith in Farmers

The historic disposal of the public domain into the private hands of speculators, squatters, and bona fide settlers was a major step that has had long-term effects on American society. The early American faith in independent family farmers, working and living on their privately owned farmland, and the willingness to fight a revolution and gain independence to preserve these rights, was the origin of today's debate, 200 years later, over the place of the farmer and farmland in America.

The Constitution and Territorial Expansion

Vernon Carstensen, professor emeritus,
University of Washington, Seattle


BRITISH POSSESSIONS
WASH
OREGON 1846
LOUISIANA CEDED BY FRANCE 1803
NEVADA
UTAH
COLO
CEDED BY MEXICO IN 1848
KANSAS
ARIZONA
GADSDEN PURCHASE 1853
OKLAHOMA
TEXAS ANNEXED 1845
TERRITORY OF THE ORIGINAL THIRTEEN STATES AS RECOGNIZED BY GREAT BRITAIN IN 1783
CEDED BY SPAIN IN 1819
MEXICO
GULF OF MEXICO
CUBA
ALASKA
CEDED BY RUSSIA 1867

In 1787 the United States claimed a territory, just under 900,000 square miles, that extended from the Atlantic to the Mississippi, from the Spanish Floridas on the Gulf of Mexico to the line of the Great Lakes on the north. Within a century the nation had grown fourfold, and its territory now stretched to the Pacific, spread from Mexico to Canada, and included the vast region of Alaska.

This immense expansion was accomplished under the Constitution of 1787 without requiring any amendments. Perhaps more interesting is the fact that the Constitution says nothing about the right of the Republic to acquire territory because, as Alfred H. Kelly wrote in *The American Constitution*, the framers simply "neglected to make any statement on the point."

Skillful Politicians

The men who gathered in Philadelphia to write a new constitution were a group of able, experienced, pragmatic politicians, many of whom had been prominent in public life since the days of the Declaration and before. They were skillful politicians, able and willing to find accommodations and make adjustments. Their success in finding solutions and making compromises is registered in the fact that Madison recorded only three of the delegates as unwilling to sign the completed document.

In their effort to broaden and strengthen the central government, the framers seemed in no mood to disturb decisions that had already been reached about such important matters as the creation of a public domain to be managed by the central government for the common good, and acceptance of the proposition that new States formed in the western territories on the lands ceded to the central government by landed States would be admitted into the Union on a basis of equality with the original States.

Sections 3. and 4. of Article IV, among other things, provide that Congress has the power to admit new States and to make the rules and regulations respecting the territory and other property of the United States. The United States also guaranteed to every State a republican form of government.

Territorial Expansion

For a decade and a half under the new Constitution no particular difficulties were encountered in westward expansion. Territorial boundaries as defined in the 1783 Treaty of Paris were reaffirmed by treaties with England and Spain in the mid-1790's.

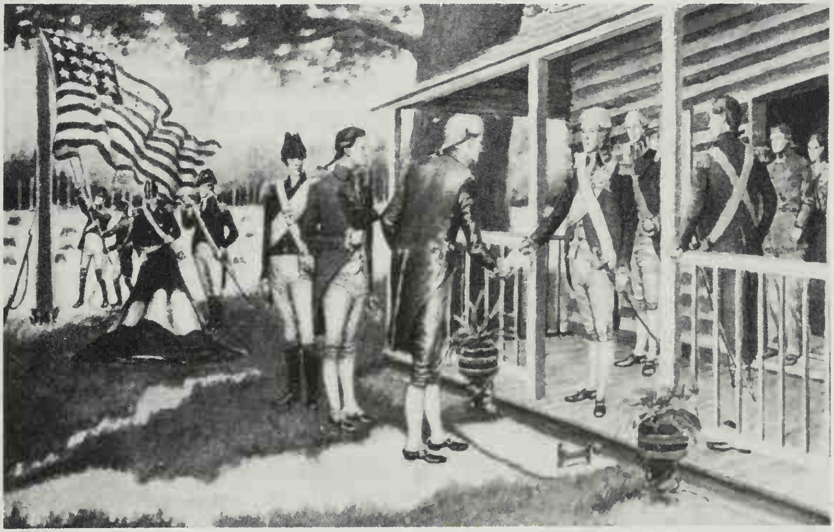
Two states, Kentucky and Tennessee, became the first admitted from west of the Appalachian Mountains; territorial organization as provided under the Northwest Ordinance of 1787 proceeded to the point that the first new State from the land north of the Ohio River was about to become a State, and the terms of the Northwest Ordinance, without the prohibition of slavery, had served as the basis for organizing the Mississippi territory. The land system, launched by the Ordinance of 1785, with provision for the rectangular survey of the land and arrangements to dispose of it, continued to unfold.

Louisiana Purchase

Matters changed when Spain closed the Mississippi River to American commerce in 1802 and word reached Washington that France had obtained Louisiana from Spain. This led to the purchase of Louisiana in 1803 and provided the first serious test of whether the new Republic could expand beyond its original boundaries under the Constitution.

Most Americans enjoy the story of this vast acquisition, largely no doubt because it is an account of rare good fortune in enlarging and enriching the Republic, thanks to what appears to be the capricious behavior of a European ruler. Pleasure in the story is not lessened because of the irony involved when holders of strong ideological positions found it necessary to reverse themselves in public view.

The facts are relatively simple if somewhat unbelievable. In 1800 Napoleon Bonaparte had arranged for Spain to return Louisiana secretly to



France transfers the Louisiana Territory to the United States in 1803. (Pictorial History of the Louisiana Purchase *by Murat Halstead)*

France. It was to serve a part in the reestablishment of a French colonial empire. The plan went badly. Napoleon lost interest in the project.

Meanwhile, President Thomas Jefferson was much disturbed by the closure of the Mississippi and return of Louisiana to France. He directed Robert R. Livingston, the partly deaf American minister to France, to try to buy New Orleans and West Florida, or, failing that, other landing rights on the lower Mississippi and Gulf Coast. In March 1803, he named James Monroe special envoy and sent him to France to assist in the negotiations.

Livingston's repeated proposals and entreaties to Bonaparte and his ministers were ignored. Then early in April Napoleon instructed his ministers to find out what Livingston would offer for all of Louisiana, not just New Orleans and West Florida. On April 11 Talleyrand casually asked Livingston what the United States would pay for the whole of Louisiana.

His first startled response was that the United States did not want the whole of Louisiana. But he recovered quickly. Monroe reached Paris the next day and after some haggling the Ambassador and special envoy arranged for the purchase of Louisiana. It was an amazing agreement between Bonaparte's ministers and the Americans who went some distance beyond their instructions. Livingston and Monroe had been directed to obtain New Orleans and West Florida for up to $10 million. They agreed to pay over $15 million for all of Louisiana. The treaty promised that the inhabitants of the ceded territory would be incorporated into the Union of the United States as soon as possible, "with all the rights, advantages, and immunities of citizens of the United States."

This was something that the Secretary of State had said should not be promised, but Livingston and Monroe agreed to it. To some, the transaction appeared to be one in which the Americans had no authority to buy what the French ministers had no right to sell.

The Great Bargain

The treaty offered Americans a great bargain, but it also put a severe strain on the Constitution as Jefferson and his followers had viewed it. For years Jeffersonian Republicans had been denouncing the Federalists for interpreting the Constitution liberally to suit their purposes. Now it was Jefferson who must seek a flexible interpretation.

Initially he considered proposing an amendment that would explicitly authorize such acquisition of territory, and even tried to find satisfactory phrasing, but he was warned that haste was needed lest Bonaparte change his mind. He was persuaded to acquiesce, confident, as he wrote a friend, that the good sense of the country would make corrections in the Constitution if evil effects threatened.

The Treaty involved an appropriation, so both houses of Congress, each controlled by Republicans, acted on the measure. The Nation was treated to the view of Republicans arguing forcefully for a liberal construction of the Constitution and the Federalists standing firm against making a "blank paper" of the document. But the debate was soon over and the treaty approved by a vote of 90 to 25 in the House, by 26 to 5 in the Senate. Ideology could not stand against so great a bargain.

Congress and the administration next turned to the business of arranging a proper transfer of the territory, and then to its government. There was some uncertainty about the status of the new territory. Was it a colony, to be ruled by the central government, or was it to be viewed as an enlargement of the public domain, a region in which new States would one day be formed under the general provisions in the Northwest Ordinance?

The first government provided for Louisiana in 1804 seemed to view it as a dependent colony. The president of the United States was authorized to appoint the governor, the legislative council, and the judiciary. This arrangement worked badly and a year later Louisiana was granted an elective legislature and in other ways brought into the territorial system. Moreover, unclaimed land became part of the public domain to be covered in time by the rectangular survey and the established land policy.

Admitted to the Union

In 1812 Congress admitted Louisiana to the Union on a basis of equality with the other States. Both the system of territorial government and the land system had been extended to the acquired territory without placing a noticeable strain on the Constitution.

After the absorption of Louisiana, the United States went on to acquire the Floridas, Texas, the Oregon country, California and the other southwest territories, the Gadsden and Alaska Purchases, and finally, in 1898, Hawaii without notable constitutional difficulties. In 1810, urged on by American settlers, that part of West Florida lying west of the Pearl River was attached to Louisiana Territory by Presidential Proclamation. President Madison asserted that this territory was widely known to be part of Louisiana and the time had come for the United States to accept responsibility for governing it.

The Governor of Louisiana was directed to assume control. The Spanish Government complained but got nowhere. Two years later Congress passed a law declaring that the lands lying between the Pearl and the Perdido were part of the United States and attached to Mississippi Territory. Again Spain protested but did nothing. Then in 1819 Spain agreed to transfer East Florida to the United States.

Residents of Florida were promised full rights of citizenship. It took 2 years before the ratification was completed and the United States took possession. Initially Florida's government differed little from the one first provided for Louisiana, in that the president appointed the governor, legislative council and judiciary. This was changed within a few years to provide for an elective legislature, and the laws governing the survey and sale of the public domain and territorial government were spread over Florida.

Treaties that Followed

In the expansion following acquisition of Florida, all went relatively well. Texas, held out of the Union because of mounting sectional conflict, entered the Union in 1844 with full statehood on the basis of a joint resolution and with control over its own public land. The areas brought into the Union in consequence of the Oregon Treaty, the Southwest Cession, Gadsden Purchase and Alaska Purchase were incorporated into the territorial system.

After the Louisiana Purchase, new territory could be acquired and attached to the Republic without provoking much constitutional debate. But from the time of the Missouri Compromise of 1820 until the Civil War the increasingly bitter sectional conflict made it more and more difficult for the Congress to exercise its explicit constitutional power to admit new States. In the case of Alaska, governmental development was as slow as population growth. The rectangular land surveys and the land system in general were spread over these acquired lands with no difficulty.

The Constitution contained no statement about territorial expansion, but neither did it contain any "parchment barriers," a term used by John Randolph of Virginia in the debate over the Louisiana Purchase.

Farming at the Time of the Constitution

John T. Schlebecker, former curator,
National Museum of American History, Smithsonian Institution

"New States may be admitted by the Congress into this Union. . . ." Article IV, Section 3, Constitution of the United States.

At the time of the Articles of Confederation, and the early days of the Constitution, most people in America engaged in some agricultural pursuit. Their fairly wide dispersal in separate homesteads and also across a variety of climatic and topographical zones may well have played a greater part in the writing and adoption of the Constitution than any other aspect of American agricultural life. The Constitutional Convention welded a widely separated and agriculturally diverse population into an effective union.

We the Farmers

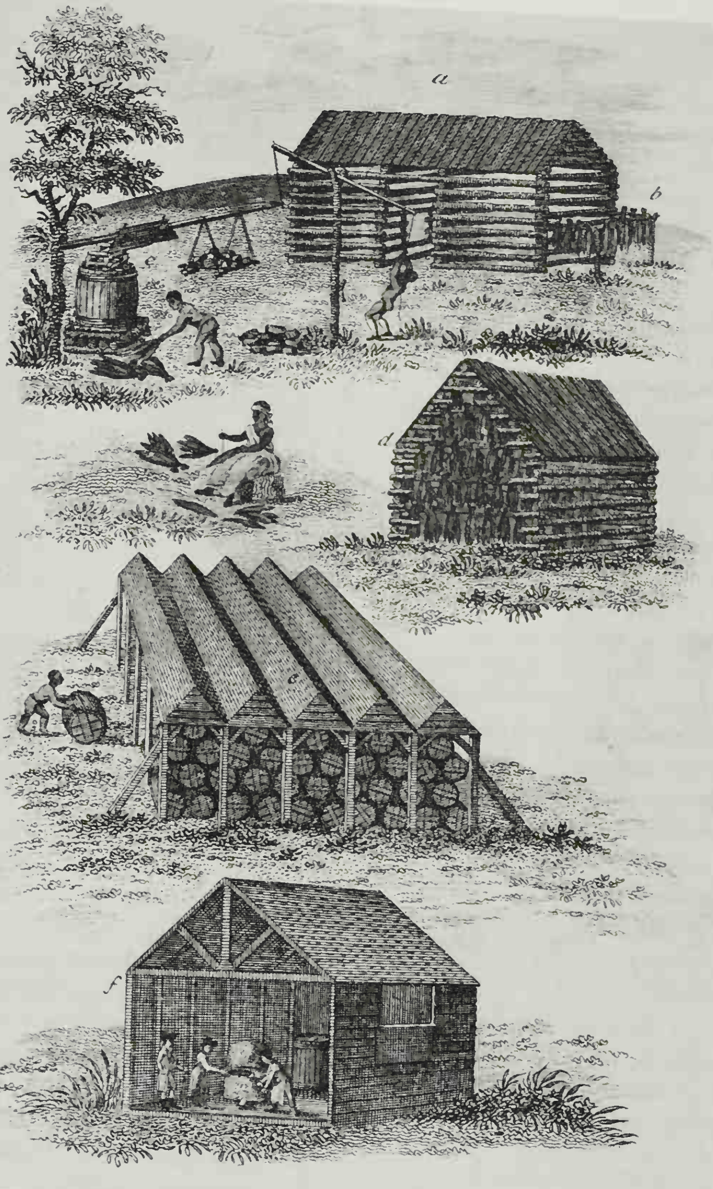
At the time it was written, the first words of the Constitution, "We the People," overwhelmingly meant farmers. The Constitution sought not only to provide a suitable government for all sorts of farmers, but for all kinds of future farmers following other agricultural systems and growing new crops. Many of the Founding Fathers also had visions of an industrial America, but their immediate concern was a nation of farmers.

Climatic Divisions

Climate had already subdivided America into agricultural regions. By the time of the Constitution, most Americans no longer carried on frontier self-sufficient farming. All regions engaged in commercial agriculture. Everywhere, they used corn for subsistence, but other specialties had developed as commercial enterprises.

New England Timber. The timber industries of New England were a form of agriculture. Clearing the woods and selling logs either resulted from or preceded the opening of land for farming and settlement. New Englanders also specialized in various forms of animal husbandry. Sizable shipments of cattle, hogs, and horses moved in domestic and international commerce. Exports of animals went to the West Indies and parts of Latin America.

"Bread Colonies." In the middle Atlantic States, farmers had long produced various grains. Before the Revolution the colonies of New York, Pennsylvania, New Jersey, and Delaware were known as the "Bread Colonies." Overseas markets for American grain developed more rapidly with independence and even more



Tobacco, important for revenue, trade and export, was a flourishing industry at the time of the Constitutional Convention. An 1800 illustration shows steps in its production. (Library of Congress, from An Historical and Practical Essay on the Culture and Commerce of Tobacco *by William Tatham.)*

when the government of the Constitution arranged trade agreements with European nations. The need for this commerce and its regulations strongly influenced the members of the Constitutional Convention in writing and adopting the Constitution.

Upper South. The upper South, consisting of Maryland, Virginia, and northern North Carolina, had long been heavily devoted to the commercial production of tobacco. Indeed, tobacco was America's first and most important export crop, and remained so at the time of the Constitution. Still, the upper South also produced large amounts of foodstuffs from grain, to vegetables, to livestock. Even so, the area chiefly depended on tobacco for revenue and trade.

Lower South. The lower South, consisting of southern coastal North Carolina, and South Carolina and Georgia, had not yet developed the cotton industry. Likely the Founding Fathers had no idea that cotton would one day be the great export crop of America—that, in fact, cotton would provide the balance of payments needed to start the American Industrial Revolution.

At the time of the Constitution, however, the lower South actually depended commercially on rice and indigo and on a lively animal industry. Hogs supplied meat for the merchant fleets operating out of Charleston and Wilmington. Drovers regularly moved cattle northward to markets in Alexandria, Philadelphia, and New York.

Indigo had been profitable largely because the British had given it preferential treatment in trade. Such preference ended with the Revolution, and shortly indigo disappeared as a commercial crop.

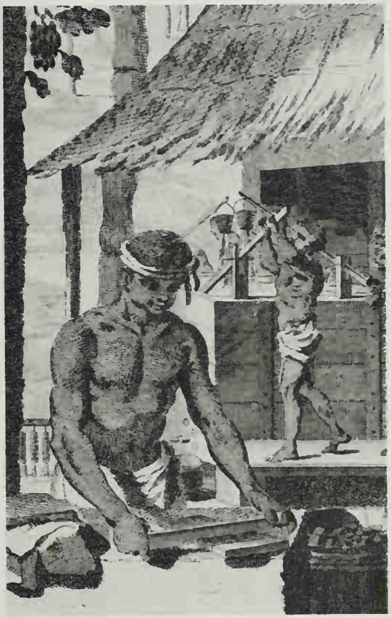
Rice planters and farmers, however, continued production nearly everywhere in the lower South, by streams or away from them. Rice remained important well into the next century, even after cotton had appeared.

Admission of New States

The Constitutional Convention also dealt with the vast land areas already part of the United States, but not yet organized as States. Aware of their own break with Britain that had come about because of being held in an inferior status, and influenced by strident demands of farmer-settlers in these areas, the Founding Fathers decided not to encourage rebellion. And so they provided for bringing all the territories into full partnership with the original 13 States.

Westward Expansion. This might not have happened in quite this way had it not been for the continual advance of the frontier, which not only populated distant lands, but also brought farmers onto the routes of the western waters.

Farmers in the valleys of the Ohio, Mississippi, Missouri, and other great rivers did not need the markets of the eastern seaboard; they could not even conveniently reach them. The great routes of transport in the interior went downstream, ending in the Mississippi and the port of New Orleans. The considerable surpluses of



Indigo, an early major commercial crop in the Carolinas and Georgia, required a large amount of labor. This drawing shows indigo manufacture in the South. (Library of Congress, G 3910 1780.F3 Vault, from a "Map of South Carolina and a Part of Georgia," 1780)

grain, livestock, and meat products cried for a route out. Spain, at the time, controlled the way to the markets of Europe and even the cities of the eastern seaboard.

Had this agricultural surplus not existed, and with it the threat of an independent interior nation, the Founding Fathers might not have taken such care to assure the attachment of the newly settled areas west of the Appalachians.

This policy designed to deal with the valleys of the Ohio, Mississippi, Cumberland, and the Missouri Rivers came to be set in place long before the United States acquired New Orleans and the vast interior of the Louisiana Purchase. When settlers moved into Alabama, Mississippi, Tennessee, and Kentucky and when pioneer farmers in Ohio, Indiana, Illinois, and Michigan wanted statehood, the machinery had been worked out. At the time of the Constitutional Convention, however, these areas participated in the farm economies of adjacent regions.

Spanish Regions. Up from New Spain into Texas, up from the south to Santa Fe, and up from Mexico to California, the Spanish pioneers, partly cattlemen and partly missionaries, moved their own culture and agriculture. These areas, which probably no one of the Founding Fathers thought would ever enter the American republic, already flourished in 1787.

Although not heavily populated, farmers and ranchers lived there. Stockmen led the advance into the Spanish-Mexican Far West. The missions particularly developed trade either in live animals, or in byproducts such as hides, tallow, and wool. The Spanish and Mexican pioneers brought their own systems of land tenure, social organization, technologies and values.

Texas, California, Hawaii. The admission of Texas and California, both settled by Spanish and Mexican pioneers and both independent nations for a while, reflects the success of the Constitutional provisions for statehood. The same process worked again when the independent country of Hawaii was introduced into the Union. And these three States were predominantly agricultural at the time of their admission.

A Workable System

Those who wrote the Constitution sought to strengthen the United States, preserve the Union, and provide for the possible expansion of the federated republic. They were inspired in part by the needs of an agricultural society. The system has worked, and worked well for two centuries, in large part because of one simple sentence in Article IV, Section 3, of the Constitution: "New States may be admitted by the Congress into this Union. . . ."

Trees and the Bicentennial

When deliberations got too hot in the summer of 1787 in Philadelphia, delegates to the Constitutional Convention could "cool off" under the shade of a spreading tree. Today trees are the only living witnesses to the signing of the U.S. Constitution, living legacies of our Nation's history. That's why the Forest Service deemed it appropriate to sponsor a yearlong national program to plant "Constitution Trees" in 1987 to commemorate the bicentennial of the signing. Trees are a fitting tribute to the Constitution's strength and endurance.

To get the tree-planting program off to a good start, the Forest Service planted Constitution Trees on Arbor Days at its installations throughout the country. The plantings were commemorated with ceremonies and plaques and emphasized the tree's role in the Nation's history. On April 24, Arbor Day for Washington, DC, Forest Service Chief F. Dale Robertson planted a willow oak in front of the new Forest Service's headquarters building in Washington DC.

In addition to the individual tree-planting ceremonies, Forest Service field offices participated enthusiastically in other Constitution Tree projects. Some dedicated their 1987 National Forest tree-planting effort to the Constitution Bicentennial. Others selected existing groves of 200-year-old trees in National Forests for designation as "Bicentennial" or "Constitution" Trees. And still others worked with State natural resource agencies to develop tree-planting projects throughout those States.

The Forest Service also encouraged the public to plant Constitution Trees. It suggested that communities and private citizens include tree-planting ceremonies as part of local and personal observances during the year. To help this effort, the Forest Service prepared and distributed a brochure "Plant A Tree for the Bicentennial of the Constitution" which contained tips on selecting, planting, and caring for a tree. All in all, the Forest Service anticipates that 1987 will end up by having the Nation's largest tree-planting effort ever.

Changing Patterns of Settlement

Part II

Transformation of the Land in Colonial America

Thad W. Tate, director, Institute of Early American History and Culture, Williamsburg, VA

The earliest European settlers and the explorers who preceded them approached eastern North America with feelings of apprehension and optimism. On one hand, they believed they had found a vast wilderness of unbroken virgin forests inhabited by uncivilized peoples. The prospect stirred a deep-seated fear of wild lands.

Yet, at other times the New World appeared to promise inexhaustible riches, evoking images of pastoral beauty as when the Jamestown settler George Percy described "the ground all flowing over with fair flowers of sundry colors and kinds, as though it had been in any garden or orchard in England."

Above all, however, those who organized colonial ventures and the settlers who carried them out perceived the land to be a source of valuable resources for European markets and personal enrichment.

Colonial Landscape

By any European measure the regions to which the first colonists came were heavily forested, yet extensive areas of open grass and marsh land had been created by such natural circumstances as fires, storms, varied soil conditions, and proximity to water. Both the contrast between cleared and wooded lands and the widely differing composition of tree stands, even within comparatively small areas, created a precolonial landscape that has been aptly described as a patchwork.

Despite European perceptions, eastern North America was not a pristine wilderness. It was a managed landscape, one that the American Indians over many centuries had modified extensively—and in the light of their cultural and material needs—efficiently. Indians had cleared much land for agriculture. Likewise they followed a practice of systematic woodland burning sometimes as part of the process of clearing arable land but also to improve woodland graze for game, to ease passage through the forests, or to clean up insect-infested village sites.

Indian Land Use. The Indians along the east coast subsisted through an intricate combination of hunting, fishing, and agriculture. Fishing often coincided with annual spring spawning

The primeval forest of central New England in 1700 consisted of mixtures of coniferous and broad-leaved trees. The forest had undergone drastic changes periodically from fires, windstorms, and hurricanes. (Photo of museum diorama courtesy of the Harvard Forest, Harvard University, Petersham, Massachusetts)

runs; hunting was primarily in the fall, when game animals were fattest. Seasonal hunting helped prevent serious depletion of the game supply, although Indian braves ranged over large areas. Agriculture extended from spring planting through the last fall harvests, and, for the Indian no less than the European, produced the most extensive modification of the landscape. Indians practiced slash-and-burn agriculture moving their fields frequently as soil became exhausted and clearing new fields by killing or burning trees and planting among the remaining trunks and stumps. Cultivating the land with crude hoes, the Indians grew maize, or corn, planted in hills and added gourds and beans that could climb the cornstalks. Despite the persistent myth that New England Indians taught the European settlers to fertilize by putting fish into corn hills, the aborigines did not seem to fertilize their crops.

Although slash-and-burn agriculture produces relatively poor yields and looks slovenly, it was an efficient method for small Indian populations living on forested lands because it required minimal labor. Light cultivation without total clearing likewise prevented serious erosion, and the mixing of bean and corn crops preserved some soil nutrients and delayed soil depletion for a time. Shifting fields also allowed heavily used land to recover fertility. Indians were not so much conscious ecologists, as they were people with a strong sense of dependence on nature, but without urgent pressure to supply consumer demands. Their environmental impact on the landscape was limited, but Indians did use the land more extensively than the first Europeans.

European Adaptation. The colonists demonstrated other misconceptions about the American land. They failed to realize hopes for quick exploitation of tropical products, metals and the like except for forest products such as timber, naval stores, and potash. Little attention was paid to agriculture beyond the assumption that colonists should produce their own food. Those who arrived in the first waves of colonization intended to raise European grains, such as wheat and rye, and to employ the plowing methods to which those crops were suited. Europeans also sought to introduce cattle, pigs, sheep, and other livestock that formed an important part of food production at home. They quickly discovered that the soils were often unsuitable for European grains, and that clearing fields sufficiently for planting or for pasturing animals was all but impossible.

Colonial Americans never entirely lost their vision of the European pastoral landscape with its highly cultivated fields and its pastures and meadows. Nevertheless they found themselves adapting of necessity to Indian methods and crops. They applied slash-and-burn techniques of girdling and burning trees and learned to like the corn that could be grown more readily on such land. They allowed their animals to roam the vast uncleared woodlands and to forage for their food. In the rapidly emerging tobacco economy of the colonial Chesapeake, settlers even found a major market crop they could produce by hoe cultivation in partially cleared fields.

European travelers were critical of such an agricultural system as were some colonists, although it struck a workable balance between scarce labor and plentiful, but uncleared land. Moreover, even though tobacco and corn crops exhausted soil fertility rapidly, colonial farmers were able to shift fields, leaving old fields fallow over long periods to recover fertility.

European Practices. Colonists eventually cleared fields more completely and sought to cultivate them more intensively. They turned back to familiar European grains and grasses and the use of plows, although continuing to cultivate corn. They created bounded and defined spaces by erecting fences, at first to keep free-ranging livestock out of cultivated fields and then to pasture them and improve the breed.

These changes came gradually to the older settlements as events required a more intensive use of the land.

As settlement spread westward, however, the kinds of agriculture practiced by the Indians was popular with the pioneers.

By the mid-18th century agricultural reformers such as the New Englander Jared Eliot had become advocates of the use of improved plows and seed drills, continuous crop rotation between grasses or legumes and grains, and extensive fertilization. More prosperous and more highly

A 1740 New England farmstead shows land cleared of trees. To the settlers, wood was a resource that appeared to be inexhaustible. (Photo of museum diorama courtesy of the Harvard Forest, Harvard University, Petersham, Massachusetts)

educated colonists exhibited greater esthetic appreciation of a developed landscape, whether in the form of ornamental gardens or neatly cultivated agricultural lands. More than a century of settlement had wrought a significant transformation of the American landscape.

Detrimental Effects

Agricultural improvement European style had its darker side. Some of the oldest areas settled were already experiencing acute timber shortages. Some rivers, such as the Piscataway on the New Hampshire-Maine border, had become clogged with sawdust from the cutting of timber and no longer supported fish returning to spawn.

Reduction of woodland habitat, excessive hunting and trapping of animals to supply the international fur trade, and deliberate extermination of predators such as wolves and bears to protect free-ranging domestic livestock had decimated many animals species. The introduction of European flora, both cultivated plants that were deliberately imported and destructive weeds that were accidentally brought, and extensive land clearing had vastly changed North American ecosystems, not always for the better.

It was impossible for those who lived at the time to understand the magnitude of the ecological revolution that had occurred. The good effects of an open, cultivated, and productive landscape were apparent, but the more detrimental consequences of the process often were not. Seemingly limitless unsettled territory to the west reinforced the idea that land resources were boundless. The urge was to conquer and exploit the landscape, especially by the rapid transfer of the public domain to private control, rather than to preserve it. The colonial experience had served more to confirm and intensify than to temper the strong exploitative drive that had characterized initial colonization.

If the settlement of North America had begun with conflicting attitudes of fear of and attraction to the natural setting, the colonial era drew to a close amid another set of contradictory influences: a desire on the one hand to nurture a landscape and a determination, on the other, to dominate and exploit it. This dilemma has colored the history of the American land ever since.

Our Basis for Wealth Was Land

William D. Rowley,
professor of history,
University of Nevada, Reno

Americans were acutely aware of the commercial and social value of land long before they achieved their independence in the late 18th century. Vast stretches of land, which Americans treated as a commodity, lay beyond the Appalachian Mountains and far into the interior of North America.

Speculators Abounded

Attempts to lay claims to land influenced the course of colonial and early national history as such companies as the Ohio, Transylvania, and Susquehanna carried out surveys, negotiated with Indian tribes, and promoted purchase schemes from the individual colonies in hopes of promoting sales to incoming settlers at handsome profits.

Land and its attendant riches were to prove the great bonanza for those with an entrepreneurial bent as well as the settlers on the land. It represented the riches of British America like the riches of the fur trade in New France and the gold of the New World in the Spanish Empire.

Enduring Form of Wealth

Land proved an enduring and versatile form of wealth. It persisted from generation to generation. When its fertility declined, Americans sought new lands in the West. The quest for new lands was hurried along in part because of wasteful, improvident land use that valued labor more than land. The value attached to these new lands turned them into a source of capital for a wide variety of developmental needs.

Land values provided social overhead capital in governmental services—capitol buildings, prisons, mental asylums, common schools, universities. For economic development they provided town sites, underwrote internal improvements, rewarded military service, backed local bank credit, and subsidized water projects, mining, grazing, lumbering, immigration, and the development of the farm unit itself.

Cultural Adversaries

Although the lands ceded by the States to the Confederation government during the Revolution were long regarded as a vast revenue source for the central government, they were not unoccupied. Numerous native American tribes lived upon the land.

To occupy it, Euro-American farmers had to displace them in a struggle that pitted an agricultural and potentially urban industrial society against a hunter-gather culture that did not regard land as a commodity.

A plentitude of land gave the U.S. Government the options of offering reservations and after the purchase of Louisiana in 1803 the removal of the tribes to the tractless expanses beyond the Mississippi.

The land from which tribes were removed East of the Mississippi was not land bought by the United States at great expense. After victory in the Revolution, the Nation considered itself the ultimate owner of the land. Indians enjoyed the rights to use the land until those rights might be negotiated away, purchased, or seized as punishment for Indian war. While one might argue the legitimacy and morality of this view, the Nation was in possession of a landed inheritance that could be turned into instant capital for the development of states, roads, canals, railroads, and a myriad of other projects related to American growth, expansion, and modernization.

From revolutionary times onward, land bounties were used to induce soldiers to serve and reward them after their service. Generous land legislation lured settlers to the Oregon country to make more secure American claims against the British.

Source of Capital

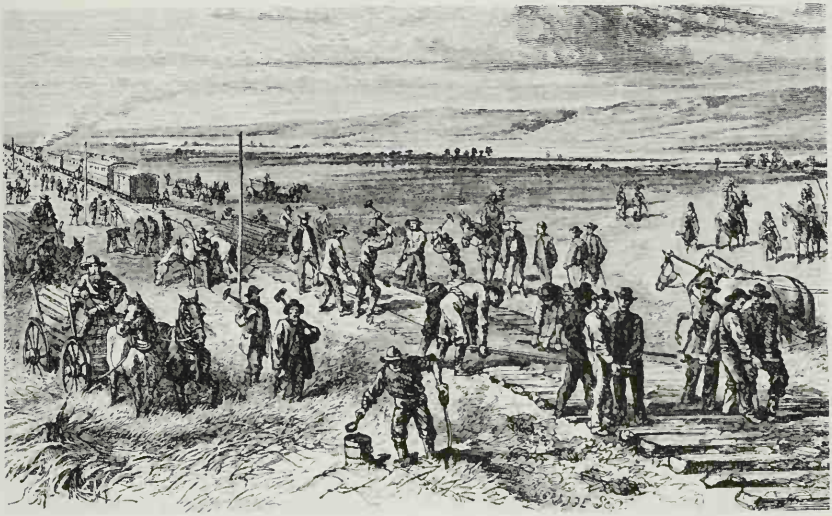
Foremost, land was a boon to the agriculturalist, but its benefits did not stop with yeoman farmers. The land and the wealth it represented and produced helped speed the country along the road to commercialism and ultimately to an urban industrial society. The accumulated capital represented by this landed heritage and its shrewd transformation into the production of other types of wealth meant that the United States could avoid long periods of self-sacrifice and denial in the accumulation of capital necessary for urban industrialization.

In classic Marxist terms it provided the "primitive accumulation" of capital for which other societies were required to make great sacrifice in terms of human energy, freedom, and consumer goods. On the other hand, the land did absorb so much of American energies that industrialized development was possibly slowed. Still it eventually produced a labor force that flocked to the cities along with overseas immigrants to industrialize America.

It Generated Freedom

In a sense the land enabled the United States, in the words of political scientist Louis Hartz, to be "born free"—free of a social and economic system that confined privilege and deference to the few in possession of the limited amount of land available. With unlimited land possibilities, positions of privilege were within the reach of greater numbers.

Some called it democracy. This did not mean that wealth, security, and position simply came for the asking. Many times the land sales methods excluded those without capital, saddled



Land grants to railroad companies for building railroads to the Pacific after the Civil War spurred the development of internal transportation. This 1867 wood engraving shows the building of the Union Pacific Railroad in Nebraska. (Library of Congress, LC-USZ62-43322)

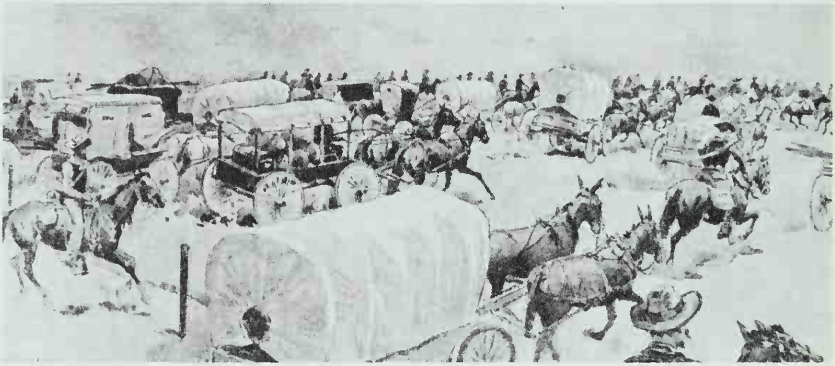
some with enormous debt making them prey to fickle market conditions, and ground others into poverty because the products of the land were insufficient or not marketable.

Despite its many risks, land settlement and development went forward on many fronts expanding rapidly in boon times and faltering after the bubble burst. In this process of "alienating the public domain," the National Government used lands to direct social development, political expansion, stimulate conservation for resource use, and provide social overhead capital for new State institutions.

Statemaking

Statemaking was an expensive process. In the Enabling Acts that created new State governments, Congress granted lands for building State capitol buildings, prisons, public asylums, and in 1841 granted lands for internal improvements. These lands were not designated at a specific sight where the structures were to be built, but were granted to States to sell for revenues to underwrite social overhead capital improvements.

From the beginning of American land legislation in the Land Ordinance of 1785, the Nation pledged Section 16 of each township to the States for common schools, and later in 1841 section 36 was added. With the enactment of the Morrill Act in 1862 land grants were made to States for the financing of colleges and universities. For Eastern States without public lands, tracts of land in Western States



Homesteaders rush for land at the opening of the Cherokee Strip in Oklahoma on September 16, 1893. (Library of Congress, LC-USZ62-801, on-the-spot sketch by H. Worrall)

were consigned to be sold under this act for land-grant colleges in the East.

Lands for Individuals and Corporations

While lands helped to finance the structure of State government and the expensive tasks of education, land also was received directly into the hands of individuals and corporations. Land grants to railroads to build rails to the Pacific after the Civil War extended huge land subsidies to railroad companies.

In spite of the corruption, this was one of the most effective internal development programs that the Federal Government inspired in the 19th century. It was the highpoint of government use of land to underwrite internal transportation development. In turn, railroad companies used land to entice immigrants and underwrite their transportation. The land values served to back the notes of many banks underwriting a liquid form of exchange that would not have otherwise been available.

Whether land should be cheap or even free to those who would settle it or priced according to market forces for governmental revenue had long been a standing debate between the East and the West. Westerners and cheap land advocates achieved a major victory with the Preemption Act of 1841. The cost of already settled land was fixed at $1.25 an acre for up to 160 acres of land removing it from the bidding process. This freed "squatters" from the threat of bidding on land they had improved guaranteeing to them 160 acres of land at minimum government prices.

Not until 1862 was the long-awaited Homestead Act passed. It gave 160 acres of free land to heads of households who settled and lived on it for 5 years and paid a $10 filing fee. With 160 acres of land available each under the Homestead Act, the Preemption Act, and the 1873 Timber Culture Act, an individual could possess 480 acres of virtually free land from Uncle Sam after the Civil War.

Some have argued that the land subsidy to American farmers in the 19th century justified government programs of agricultural subsidies in the 20th century, because government was somehow obligated to continue what it had started in the earlier century.

Still, the availability of larger land units did not make for more successful land use in the arid West. John Wesley Powell said in his *Report on the Lands of the Arid Regions of the United States* in 1878 that land units should be no less than 2,560 acres located according to the contours of the land in valleys and along water sources for economically viable ranches and farms. In 1877 Congress made its ultimate and rather unsuccessful effort to adjust land policy for the arid area when it passed the Desert Land Act offering parcels of 640 acres of free land to individuals who would build irrigation systems for the land.

Land for Townsites, Minerals, and Grazing

Urban Development. Congress also used lands to subsidize urban development. It extended the idea of preemption to town sites in 1844 by using land to subsidize the development of trade centers and even mining towns in 1863. The Townsite Preemption law of 1844 permitted town dwellers to develop town lots without immediate purchase. They could be assured of their town lots at a minimum price when survey occurred and when it became necessary to obtain a patent on the lots they had improved. Subsequently in 1863 a Townsite Preemption Law addressed the problem of establishing mining towns permitting preemption of town lots, but denying the right to the ownership of minerals in the land.

Precious Metals Free. Also the minerals of the public lands, particularly the precious metals of gold and silver, were offered free including generous land grants for mining and mill sites. The precious metals industry enjoyed a special status and protection on the public domain that promoted its quick development under the mining acts of 1866, 1870, and 1872. These minerals were literally a gift to whomever discovered them and boon to their development.

Free Grass. If mineral resources were a gift to the miner and certainly to the mining corporation, so was the open and free range a gift to stock grazers. The Cattle Kingdom of the Great Plains from 1867 to 1887 thrived on the free grass of the unclaimed public domain. After disastrous reductions in herds because of severe winters, drought, and overgrazing, ranchers and stock corporations continued to use the free and open range from their home ranches acquired under the various land acts from the Civil War to the Stockmen's Homestead Act of 1918 that granted 640 acres of free land for ranching.

Land for Conservation and Reclamation

With the coming of the conservation movement in the 1890's, the Federal Government set aside millions of acres of public land from entry and claims to promote conservation, especially the conservation of forests. The reserved forest lands that eventually became National Forests protected forest resources such as timber, forage, and watershed.

The objective was to promote their long-term use for economic benefit by applying scientific management. Conservation policies furthermore were to insure the continued vitality of industries and communities dependent upon the renewable natural resources that these lands produced and harbored. Use of the resources, except water, was predicated on payment for the resource. Still the payment, especially for forage, was below market value and continued to be a subsidy to the stock industry on both forest lands and public lands administered by the Grazing Service after 1934 and the Bureau of Land Management after 1946.

Another aspect of the conservation movement was the establishment of National Parks. These scenic wonders, Yellowstone and Yosemite to name but two, preserved and exhalted wilderness beauty underwriting the appreciation of wild beauty and eventually the development of a tourist industry in these regions.

After the beginning of the 20th century, in the 1902 National Reclamation Act Congress applied revenues from sales of western lands to the building of western irrigation projects for arid land farming. Clearly this was a subsidy to western water projects, reservoirs, irrigation ditches, and dams that produced hydroelectric power, much of which came on line in time for World War II industrial needs.

Thus, from the earliest times of the republic down to the needs of urban 20th century America, landed resources have served the developing dynamics of a modernizing society.

How Old Land Surveys Shaped Today's Landscape

Ronald E. Grim, bibliographer, Geography and Map Division,
Library of Congress

When traveling by plane it is fascinating to watch the landscape below. A variety of geometric patterns, which are imprinted on the land, are readily identifiable.

Changing Patterns

Along the Atlantic seaboard east of the Appalachian Mountains is a crazy quilt of triangular, quadrilateral, and polylateral arrangement of roads, fields, and wooded areas. Crossing the Appalachians into Ohio, Indiana, Illinois, and the Great Plains States west of the Mississippi, a regular checkerboard of roads and fields emerges interrupted by rivers, lakes, rough terrain, or urban areas. An unusual pattern of long, narrow rectangular strips bordering rivers is evident in the Mississippi River Valley through Louisiana, Missouri, and Illinois.

These designs are no accident. The geometric shapes come from real property surveys conducted from one to three hundred years ago. These landownership surveys establishing the initial boundaries of each parcel set the framework for future land use. Fields and wood lots were laid out within the limits of farm property boundaries. Fence lines and roads, which often paralleled exterior farm boundaries, reinforced the patterns.

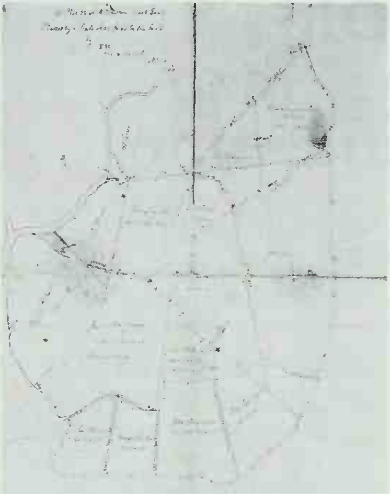
Types of Land Surveys

Most geographers and cartographers recognize a few basic types of land survey systems in the United States. Francis J. Marschner, long-time U.S. Department of Agriculture geographer and cartographer described four of them. Here is what Marschner observed with special attention to two generic types, the unregulated or "metes and bounds" surveys of the colonial period and the regulated grid surveys of the early Federal period.

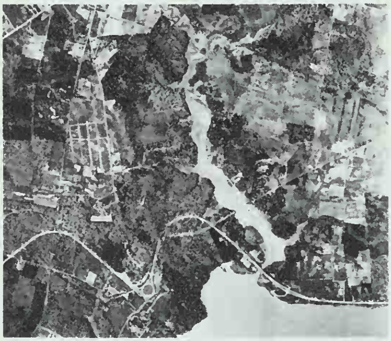
Irregular Surveys

Four kinds of surveys were used during the colonial period. All were unregulated or nonsystematic in that no plan for the geographical layout of lands preceded them.

Surveys became necessary after land was given out as grants by a royal governor, an individual proprietor, or colonial land agent to individual settlers or investors in a colonizing venture or land company. Land grants were made as rewards for military or civilian



George Washington's 1760 plat of Clifton Neck is an example of an irregular or metes and bounds survey. This tract of land, which is subdivided into tenant farms, adjoins Washington's home plantation, Mount Vernon, about 8 miles south of Alexandria, Virginia. (Library of Congress, Geography and Map Division)



This 1938 aerial photograph of Mount Vernon (center bottom) and Clifton Neck, Virginia, displays an irregular geometric pattern of fields and wooded lots some of which correspond to the property lines shown on the 1760 plat. (National Archives, Cartographic and Architectural Branch, RG 114 FG 118-147)

services, reimbursement for transporting immigrants (headrights), investment or speculative ventures, and havens for religious dissenters as well as for other reasons.

Recipients then would have desirable tracts surveyed so that the allotted acreage would encompass good farming land, mineral deposits, or other prime sites. The surveyed areas were bounded by natural features or geometric lines connecting physical objects such as trees or rocks. These were known as "metes and bounds" surveys. This practice created chaos and legal disputes when subsequent owners selected tracts overlapping neighboring tracts. These metes and bounds surveys predominate in the former British colonies from New York to Georgia.

Differences in land patterns are evident in the New England States and those areas of the Southeast, the Mississippi Valley, and the Southwest settled under Spanish and French colonial regimes.

New England States. In New England, many tracts were granted by colonial governments to town corporations. They in turn divided the land among prospective inhabitants, thus avoiding the problem of indiscriminate location and overlapping claims. Unfortunately, this more regulated system did not produce surveys consistent in lot size or shape. No prescribed plans existed for individual towns. Each town developed its own plan, some with long, narrow lots, others with rectangular plots, often aligned with rivers, valleys, and roads.

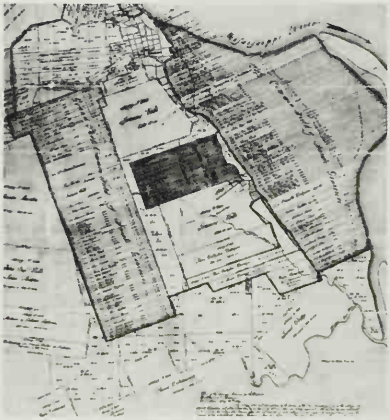
French Settlements. Areas settled under French influence used the "long lot" land survey system. To take advantage of water front locations, settlers received long, narrow grants of land along the rivers. These lots are characteristic of French settlements in Louisiana, Missouri, Illinois, Indiana, Wisconsin, and Michigan.

The Missouri settlements remained under French and Spanish control until 1804, when the United States acquired the Louisiana Territory. Land titles granted during French and Spanish occupation were honored by the new Federal Government. Owners had to prove their title to the property, before the U.S. General Land Office resurveyed lands according to earlier boundaries.

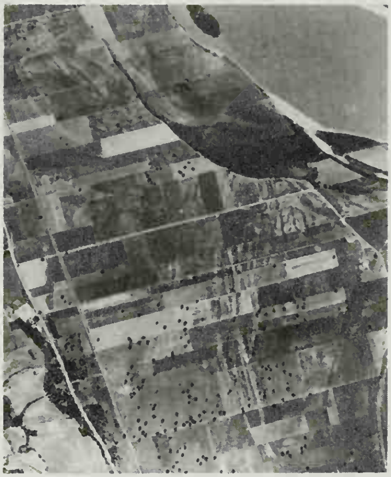
Spanish Settlements. Clusters of Spanish landholdings are found scattered in Florida, eastern Texas, New Mexico, Colorado, Arizona, and California. These grants, some fairly large, were surveyed according to metes and bounds principles, into irregular geometric shapes, with some long lot patterns evident. While similar to surveys in the British colonies, these Spanish surveys are readily recognizable because they are surrounded by a rectangular grid imposed by the Federal survey system.

Rectangular Surveys

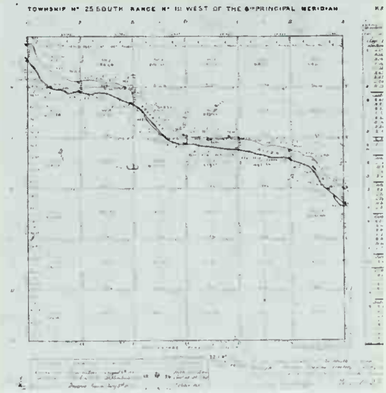
Rectangular surveys developed by the U.S. Government in the late 18th century sharply contrasted with the surveys of the colonial period. These rectangular surveys predominate over 70 percent of the continental United



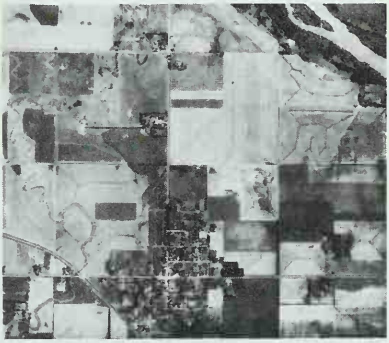
The French long lot system is apparent on this General Land Office plat of Sainte Genevieve and New Bourbon, Missouri. Although the plat was prepared in 1854, it records a pattern that dates back to the 1730's when the area was settled by the French. (National Archives, Cartographic and Architectural Branch)



The long narrow fields in a 1937 aerial photograph provide evidence of the French long lot survey system on Sainte Genevieve's Big Common Field. (National Archives, Cartographic and Architectural Branch RG 145 TT-6-645)


TOWNSHIP Nº 25 SOUTH RANGE Nº III WEST OF THE 6TH PRINCIPAL MERIDIAN

This 1860 plat of a Sedgwick County township, located on the Arkansas River about 20 miles northwest of Wichita, Kansas, is an example of the Federal Government's rectangular survey system. (National Archives, Cartographic and Architectural Branch)



The checkerboard pattern of roads and fields associated with the Federal Government's rectangular surveys is illustrated with this 1938 aerial photograph of the same area as the 1860 plat, centered on Mount Hope, Kansas. Roads follow the section lines and fields mark the quarter sections; even the town has a rectangular street pattern. The only deviations from the grid are the river and railroad track. (National Archives, Cartographic and Architectural Branch, RG-145-AYE-54-100)

States, especially in the Midwestern, Southeastern, Great Plains, and Western States.

Based on the Land Ordinance of 1785, the new Federal Government developed a land disposal and survey system using a grid of 6 mile squares oriented along compass directions. Before an area was officially opened to settlement, the lands were surveyed in this way. A base line and principal meridian were established first from which all subsequent surveys in that area were derived. Next a series of townships were surveyed. Each township, which was 6 miles square, was subdivided into 36 sections, each containing 1 square mile or 640 acres. Tracts sold as fractional portions of a section. A sample identification might read: northwest 1/4 of the northwest 1/4 of section 17 of Township 25 South, Range 3 West, of the Sixth Principal Meridian.

The first surveys under this system were executed in southeastern Ohio in an area referred to as the Seven Ranges. This system eventually was used on most lands surveyed and sold by the Federal Government. Gaining a strong foothold in northwestern Ohio, this pattern of land subdivision became the dominant pattern for the rest of the midwestern and western United States. Seen from the air this constitutes the great seemingly endless checkerboard of America's heartland.

Earlier State Surveys

Similar rectangular surveys that were not part of the Federal survey system are found in portions of the original 13 colonies (western New York, northwestern Pennsylvania, and western Georgia) as well as in northern Maine, western Kentucky and Tennessee, and western Texas) that already had established state survey systems when the township and range system of surveys was instituted. Each of these States, or land companies within the States, developed individual rectangular schemes for surveying the unallotted frontier lands. Except for Texas, these systems were developed around 1800 and were patterned after the Federal system. In Ohio, where the Federal system was first attempted, several examples of modified rectangular systems were developed by private land companies.

Surveys and Landscape

While the primary function of these real property survey systems was to establish and maintain order in matters pertaining to real property ownership, the surveys significantly influenced the appearance of the rural landscape.

Through the various types of land surveys used by early New England, French, and Spanish settlements as well as by settlements under the newly created United States Government, our land has been shaped in its many diverse and colorful patterns. As settlers laid out their farmsteads, fields, wood lots, fences, and roads, based on these surveys, they were physically and culturally changing the landscape. Today's air travelers can still clearly see and appreciate their handiwork.

Grazing Impact on Grassland Ecology

James A. Young, range scientist,
Agricultural Research Service, Reno, NV

Grazing animals have been a part of our agricultural culture from early colonial times. The term, "commons," frequently found in descriptions of colonial towns in New England, refers to the area where animals were driven to graze during the day. Often these animals were herded by children who returned their charges to the family barn each evening.

The Husbandry System

This was very much the traditional northern European approach to livestock husbandry. Animals left unattended could stray to the forest primeval and be lost forever. This husbandry system contributed to the low quality of the colonial livestock especially on the frontier. Pride was taken in the quality of oxen, however, useful both as draft animals and sources of red meat. Outstanding specimens often were shown at fairs.

The southern colonies enjoyed a more bountiful environment than icy New England, but were still pressed to the coast by endless pine and broadleaf forests. Animals were left to run loose in the woods with minimum supervision. Hogs became a range animal in the wilds. The pig, remarkably adaptable, can revert in a few generations to a feral animal that can breed and reproduce in the woods. The pine woodlands contained sufficient grass to support cattle. The colonial piney woods cattle would probably be classed as scrubs by today's standards.

Westward Expansion

The tide of westward expansion flowed through the Cumberland Gap to bring agricultural settlements to Kentucky and Tennessee. The settlers who braved the forest and the hostile natives brought their thin milch cows, sheep, and horses to the pristine mountains and valleys of the frontier. Much of this land was covered by the most diverse hardwood-deciduous forests in North America. In contrast to the Ohio Valley and the then northwest frontier which was one virtually unbroken forest, the mountains and valleys of the middle frontier contained glades and grasslands where the American bison was occasionally seen.

Not all settlers poured through the Cumberland Gap. Livestock men, accustomed to the piney woods and cane breaks of the coastal and piedmont areas, spread south and westward along the Gulf of Mexico. They encountered the five civilized tribes of native Americans with their fields of corn and squash.

Despite conflicting cultures, the grazers adopted some Indian ways. They too, began using fire as a tool. The accumulations of pine needles on the forest floor and encroaching hardwoods were burned to improve grass forage for cattle. Cattle and hogs became nearly wild in the woods, and drivers had to be organized to capture animals for slaughter or market. Log pens held the animals when they were trapped and "cow pens" became as frequent a geographic designation in the south as grazing commons were in New England.

Spanish Influence

By the third and fourth decades in the 19th century, the Spanish cattle had spread to southeastern Texas and to the missions of the southern one-half of California. The new lands animal husbandryman of colonial America slouched out of the woods of southeastern Texas and collided with his Spanish counterpart in the livestock business.

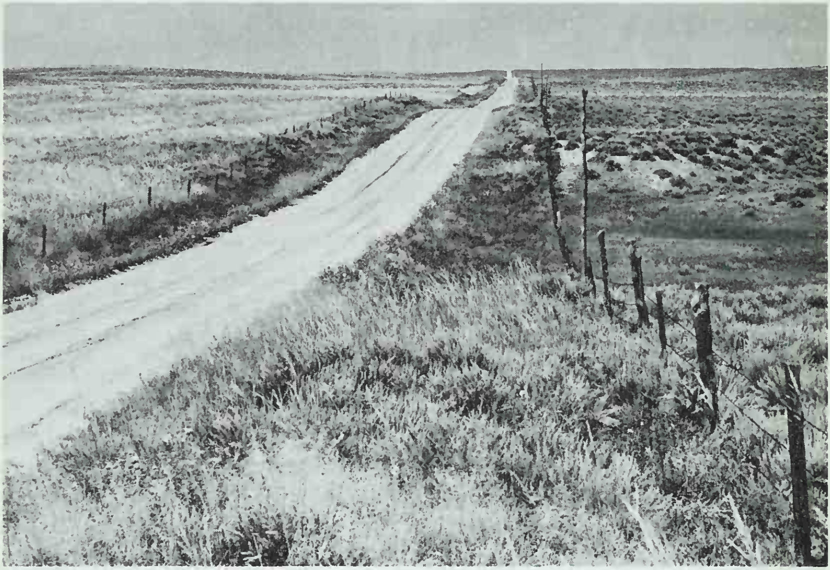
The woodsmen could ride and shoot, but survival as cattlemen in the woodlands and coastal plains of Texas required learning to herd and rope cattle while astride a horse. To do this, saddles and rawhide ropes of the Spanish herdsmen had to be adapted. This was a turbulent period in the history of Texas with conflicting Mexican-American cultures and independence moves kept in turmoil by nearly constant attacks by the frenzied, mounted warriors of the southern plains Indians. Through all of this, the Spanish cattle proved surprisingly adaptable. In assimilating the genetic input of the piney woods cattle brought by the Americans, they only increased their diversity. Virtually every color and color combination could be found in these free-breeding populations of cattle that naturalized the woods and brush country of southeastern Texas.

South Texas

The vegetation of south Texas was varied under pristine conditions, but large portions of the coastal plain and the lower Rio Grande Valley consisted of a savanna of grasslands with interspersed areas of diverse species of woody brush and small tree species. The concentration of cattle soon began to have an effect on this vegetation. The overutilization of grasses both reduced the competition they offered to shrubs and changed the frequency of wildfires by reducing fuel. Shrubs increased on the range, especially various species of the thorny legume called mesquite.

Post-Civil War Westward Expansion

The close of the bloody Civil War found the Nation on the threshold of great westward expansion. The indus-



Rangeland (far right) is badly infested with cactus and sagebrush. On the other side of the road the land was planted with crested wheatgrass 5 years earlier to restore its productivity and prevent erosion. (B.C. McLean, SCS, WYO-504)

trialized northeast clamored for cheap sources of red meat to feed an increasing work force. The pioneer American farmer had reached a point not previously attained in the brief history of the country. Settlers who emerged from the woods were awed by the vastness of the grasslands extending to the west. The initial transition was helped by the tall grass prairie being divided by gallery forest that escorted rivers and streams, but finally as rainfall decreased to the west of the great rivers, true grasslands were reached.

The Plains. Instead of being viewed as one of the world's greatest grazing resources, the plains became a barrier to westward expansion. The plains were populated with one of the most abundant species of large herbivore on earth, the American bison. This gigantic resource of red meat in turn supported tribes of mounted Indians, many of which were capable of ferociously resisting inroads on what they perceived as their home. The plains were something to endure by hardy pioneers willing to take the risk of crossing this vast landscape to reach the desirable environment of mineral rich California or the vividly green Pacific Northwest.

Extension of Railroads. Railroads were being extended into the grasslands of Kansas in the post-Civil War period. No local market existed for the vast number of cattle roaming south Texas, but hardy cattlemen, some of whom had driven cattle vast distances to markets in New Orleans during and before the Civil War, undertook to trail herds to the Kansas railheads. Once the cattle were out of the brush country of Texas, they were moved up the grasslands of the Great Plains. This meant they could be allowed to graze as they walked along the trail to market. Trail drivers faced severe lightning storms, flooded rivers, prolonged drought, and hostile Indians along the way, but the price differential between south Texas and the railhead produced many ready to take the risks.

Stocker Cattle. Only a small portion of the Texas cattle were marketed through the Kansas railheads. The vast majority were stocker cattle that were driven north to populate the new ranges of Wyoming, Colorado, Nebraska, Montana, and the Dakotas. Freighters were first to determine that cattle could be wintered on the plains. It had seemed impossible that large animals could survive the cold, wind, and snow of the plains without shelter and supplemental food.

Standing Hay. The freighters and pioneer cattlemen discovered that the mature grasses of the semiarid plains did not fall down and rot as was customary with unharvested forage in the humid eastern climates. The plains grass cured as standing hay. Rainfall peaked on the plains during the summer. The relatively dry winters featured fierce snowstorms called "northerners" interspersed among periods of sunshine when snow blew free from the ridges and cattle could graze the dry grass. The dry forage provided a source of energy for cattle, but lacked digestible protein.

As the livestock industry explosively expanded on the new ranges, changes in the vegetation subtly occurred. To have forage for winter, it had to be allowed to grow during the summer. If all the range was severely grazed in the fall, winter forage was automatically lacking. The Great Plains have a decided continental climate characterized by hot summers and cold winters. Drought can periodically be expected during the summer growing period, and severe winters are part of the normal climatic variation. Overstocking of the range produced declining range condition during the 1880's. Thousands of cattle died and owners were helpless to save them. This broke the back of the beef bonanza.

Livestock Production in Far West

The last great experiment in range livestock production occurred west of the Rocky Mountains. The vast temperate desert area between the Rocky Mountains and the Sierra Nevada-Cascade Ranges was at first considered outside the environmental potential for developed agriculture. This semiarid to arid region was nearly treeless in the valleys through which emigrants passed on their way to Oregon or California. Summers were nearly totally dry and what little moisture did fall came during the winter when conditions were too cold for plant growth. It truly was a cold desert outside the experiences of European-based cultures. The shrub-steppe vegetation was homologous to portions of central and southwestern Asia, where herding of domestic livestock is thought to have originated.

Miners Need Food. The Intermountain region was spotted with rich strikes of precious minerals that drew hordes of miners who had to be fed. This local market was supplied by agriculturalists adapting to the desert environment. In the portions of the Far West with higher environmental potential such as the Columbia Basin of Washington and Oregon, cattle ranching boomed much as it had east of the Rocky Mountains.

Sheep Industry Fostered. The disarray among cattlemen after the hard winters of the 1880's helped foster the range sheep industry. Often a poor man's way to gain access to the livestock industry, there developed a type of livestock culture known as "tramp sheep." These outfits owned no base property but roamed the public domain taking forage where they could find it. This produced an attitude toward range forage of "take it all before someone else gets it." In the Far West, ranchers had no means of acquiring title to sufficient rangeland to support their livestock herd.

Many of the larger, established ranchers in the West supported the formation of the National Forest system after the turn of the 20th century. Many were probably motivated by a desire to curb tramp sheep operations rather than conservation of natural resources. Grazing on the National Forest was allocated on the basis of history of use and the ownership of base properties. This granted a *defacto* right to the established stockmen.

Results of Excessive Grazing

The range area not claimed by the National Forest remained in near limbo until the droughts and economic upheaval of the 1930's forced change. President Roosevelt signed the Taylor Grazing Act in 1934 and the vacant public lands were formally closed.

Congress took an indepth look at the western range in 1936. As expert after expert testified, a picture of abuse and squandering of natural resources became apparent. On the Great Plains native prairie had been plowed for farming in areas that lacked the potential to support dryland farming. Many of these areas were so subject to wind erosion during prolonged drought that clouds of dust stretched from the heartland of America to Washington, DC.

The rich grasslands of much of south Texas and the desert grasslands of the Southwest had become choked with woody plants. This increased dominance of woody plants was a product of complex interactions between forage plants reduced by overgrazing and changes in the frequency and kind of wildfires on the range. In the cold deserts of the Intermountain area, the results of improper grazing were most apparent. The native shrubs that dominated the landscape were largely unpreferred by domestic livestock. Once the nutritious bunchgrasses were destroyed by excessive, improperly timed grazing, the shrubs gained dominance for a century or more.

Plants Degrade Rangelands

The near vacuum created by the destruction of the herbaceous vegetation was filled by the accidental introduction of a host of alien weeds such as Russian thistle, tumble mustard, and cheatgrass. These weeds had evolved in Asia with the domestication of livestock and had followed in the shadow of settlers and their flocks to the New World.

Among these alien plants was the toxic species, halogeton. First discovered near Wells, Nevada, it was not identified as poisonous until 1942. This fleshy weed spread like wildfire through degraded salt desert and sagebrush rangelands. Halogeton was capable of causing the death of thousands of sheep under the proper conditions. National publicity about this weed helped crystallize support for State and Federal legislation for its control.

The dean of American natural resources, economist Marion Clawsen, was serving as the head of the Bureau of Land Management (BLM), U.S. Department of Interior, which administered the Taylor Grazing Act. He was trying to gain control of the BLM lands from a range livestock industry deeply rooted in the 19th century tradition of free range. Based on the advice of range management experts on the faculties of State universities such as L. Stoddart of Utah and Joseph Robertson of Nevada, Dr. Clawsen adopted the policy that halogeton would be biologically suppressed through the seeding of perennial grasses rather than directly controlled by the use of tillage or herbicidal treatments. Essentially, halogeton was merely the symptom of the real disease which was the degradation of the perennial grasses through excessive grazing. The exotic crested wheatgrass, which was native to Russia, was used to restore productivity and to stabilize millions of acres of rangeland against accelerated erosion.

Environmental Interests

During the 1960's, a host of environmentally concerned interest groups became involved in decisionmaking on rangelands. Their interests ranged from archaeology to wildlife. This is a sign of the maturing of America's cultural interest in natural resources.

We are well into the second century of agricultural use of the bulk of America's western rangelands. Rangelands are a national resource that yields a diversity of products such as water and wildlife in harmony with the production of red meat and wool.

The Plants That Followed People

W. Curtis Sharp, national plant materials specialist,
Soil Conservation Service;
George A. White, plant introduction officer,
Agricultural Research Service, Beltsville, MD;
and James A. Briggs, manager, National Plant Materials Center,
Soil Conservation Service, Beltsville, MD

Plant Introduction

Imagine going shopping for fresh vegetables and finding only blueberries, cranberries, nuts, and sunflower from which to choose. These were the native food crops available to the North American Indians.

Human beings have been moving plants from one place to another since the beginning of time. The first recorded plant collection was made by Queen Hatshepsut of Egypt in 1500 B.C.

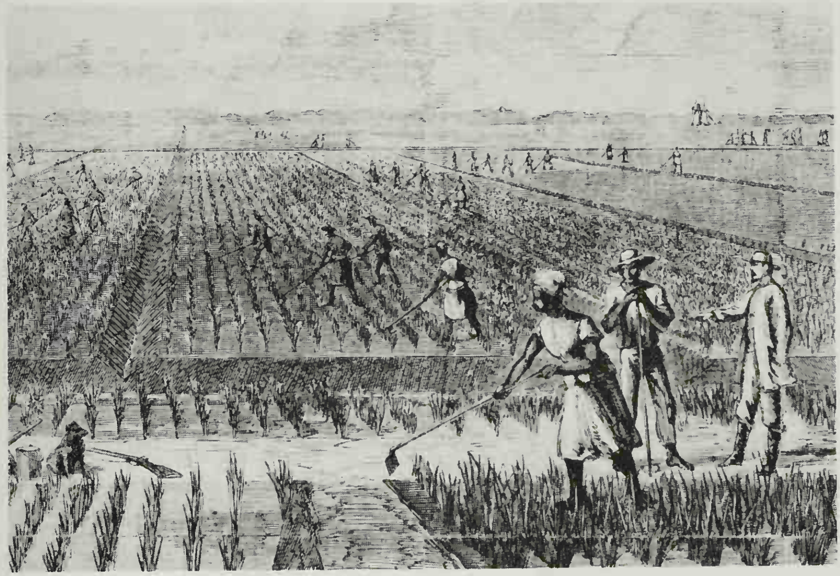
Centuries ago Indians from Mexico and southward migrated north, bringing corn and other crops. In the early days of this country, immigrants brought seed from their homeland, and suddenly barley from England and Germany stood side by side on the farmstead. Ship captains brought seed from far-flung parts and Spanish missions introduced arid land crops to the Southwest.

The systematic introduction and distribution of foreign plants began in 1898, when the Department of Agriculture (USDA) established an office on seed and plant introduction. Since the first introduction of cabbage from Russia, almost a half million samples have been officially introduced. Today, the National Plant Germplasm System continues this work of introducing, evaluating, and preserving valuable germplasm for diverse uses. In addition, USDA's Soil Conservation Service has acquired foreign plants useful in soil conservation. Universities, private arboretums, and individuals also have introduced foreign plant material in their work. Unfortunately, unplanned and illegal introductions frequently have caused major and often continuing problems.

Field Crops

Familiar field crops such as wheat, rice, barley, oats, rye, and buckwheat were introduced by early settlers. Today, introduced cereal crops, including corn, provide about 20 percent of the food energy, 20 percent protein, 36 percent carbohydrates, 38 percent iron and a high percentage of the vitamins thiamin, riboflavin, and niacin in our daily diets.

Rice. Experimental rice plantings were made in Virginia as early as 1609, and by 1690, were well established in



Workers cultivate rice on a plantation near Savannah, Georgia, in 1867. Rice is still a popular crop in southeastern States, particularly Louisiana. (Library of Congress, LC-USZ62-93554, sketch by A.R. Waud from Harper's Weekly*)*

South Carolina. The principal rice-growing areas were located in the southeastern States for more than 200 years. Now, most of the acreage is concentrated in Arkansas, Louisiana, Mississippi, Texas, and California. The United States has become a leading exporter of rice grain.

Wheat. This ancient crop of Middle East origin has been important in the Western Hemisphere for more than 400 years. Apparently, Christopher Columbus brought both wheat and barley to the West Indies in 1494 and perhaps in 1492 as well. Since these crops failed, it remained for later settlers to establish them.

Early diversity of origins greatly speeded up the successful adaptation and production of soft, hard, and durum types of spring and winter wheat.

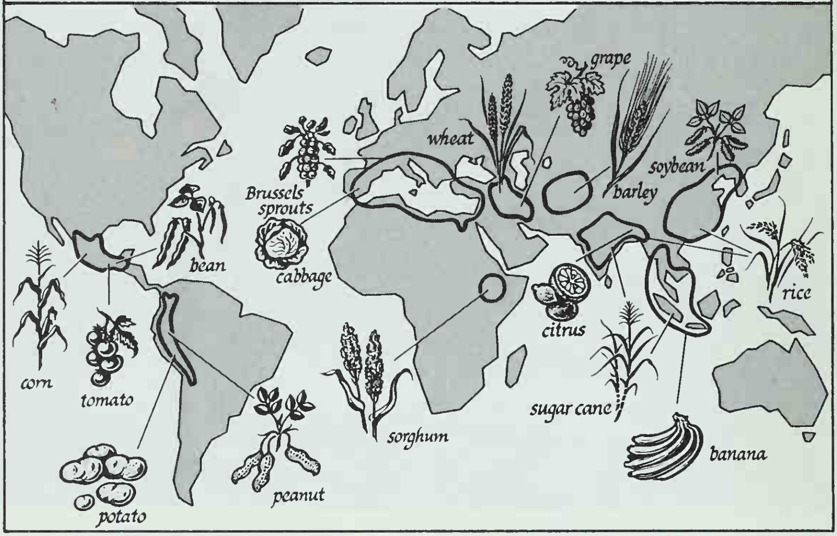
Soybeans. Soybean production now exceeds 2 billion bushels from 59 million acres with a value of $10 billion. This crop of major economic significance was first introduced into Georgia in 1765. By 1898, no more than eight varieties were cultivated.

Forages

A significant portion of cleared land was reserved by the settlers as grazing lands for their domestic stocks. Forages common to northern Europe were quickly introduced.

Alfalfa may have been first introduced in Mexico about 1736, to

Plants Introduced into the United States



become well established in the southwestern United States after 1836. Called the "Queen Of The Forages," it is grown in nearly every State.

Tall fescue was probably introduced much earlier but only came into widespread use in the 1940's, resulting from the multiplication of the variety, *Kentucky 31,* found in a naturalized stand on a Kentucky farm in 1931.

In the humid south where the cool season grasses were less well adapted, bermudagrass and others were introduced from Africa and India.

As settlers moved onto the Great Plains, they encountered first significant amounts of native grazable forage. These grasses represented the climax vegetation, but were fragile, and after decades of overgrazing, much of the area not plowed was invaded by introduced grasses, which were better adapted to intensive grazing. The principal invaders were Kentucky bluegrass and smooth brome.

Several well-adapted varieties of wheatgrasses from the Middle East, and buffelgrass, lovegrass and kleingrass from Africa, are widely used in the Rocky Mountains and Southwest.

The impact of introduced grasses and legumes on this American land far exceeds their value as forages. Except for the Great Plains, native grasses and legumes with broad adaptation are limited. The greatest long-term contribution of introduced forages may be for revegetating degraded farmland or rangeland and for soil stabilizing and building processes.

Conservation Plants

USDA, recognizing the need for specialized vegetation to combat wind and water erosion, conducts a world-

With the introduction of valuable landraces from China, Japan, Korea, and the U.S.S.R. in the early 1900's, soybeans became profitable to produce. Here, a farmer harvests soybeans in southwest Iowa. (Tim McCabe, SCS, IA-2859)

wide search for conservation plants. Many foreign plants have proved well adapted to U.S. climates. Some are better adapted than native plants for solving erosion problems.

Currently, about 78 varieties of conservation plants developed from germplasm of foreign origin are produced commercially.

Crownvetch, introduced from Northern Europe, is better adapted for stabilizing denuded slopes in the eastern United States than native ground covers and has been planted on thousands of miles of roadbanks.

Many important wildlife species depend on introduced plants for food. For instance, grain sorghum and other cultivated crops are important in the diet of ringnecked pheasants. Two annual lespedezas from Southeast Asia are a principal food for bobwhite quail.

Ornamentals

Half of the top flowering trees used in the landscape trade, including crabapple, Callery pear, saucer magnolia, golden rain tree and flowering cherry, were introduced.

Many favorite flowers also were introduced. Chrysanthemums came from China and Japan, carnations from Asia, tulips from southwestern Europe and the Near East, and poinsettias from Central America. The commonly used Japanese yews, many evergreen azaleas, tea and floribunda roses, are all gifts of foreign lands. Further, about 20 percent of the landscape trade in the southwestern United States consists of plants from Australia and other arid lands. These plants provide diversity and help in water conservation.

Safeguards

Foreign plants should not be so well adapted to climatic niches that they replace native vegetation or become weeds competing with agricultural crops. A $7.5 billion price tag is the estimated annual yield loss for 64 crops caused by weeds.

Most serious weeds were accidentally introduced by contaminants in crop seeds, seeds in ship ballast and packing materials, in hay and other feedstuffs, and even seeds in the wool and fur of introduced animals. Most of these introductions took place during early U.S. history.

Kudzu was introduced because of its potential value for hay and usefulness in soil conservation. Unfortunately, its aggressive spreading tendencies proved to greatly outweigh its positive characteristics.

Today, safeguards help protect against pest plants. The Noxious Weed Act rigidly controls the introduction and interstate movement of plant species considered a threat to agriculture and waterways. Quarantine regulations apply to plant species that might harbor exotic diseases, viruses, and insects.

Since a wide range of plant species is needed for agricultural research, procedures with built-in safeguards have been developed for importing restricted materials. Most vegetative introductions of apples, pears, peaches, and citrus must be virus-indexed before used for planting and research purposes. Corn, sorghum, and pearl millet seed from Africa and Asia must be grown under controlled greenhouse conditions before field growout is allowed.

Searching and Preserving

Worldwide interest in germplasm exchange has increased dramatically. Its value to all people is widely recognized, and the search for and exchange and preservation of germplasm must continue. This is possible only in a reasoned, cooperative atmosphere, in which all peoples of the world can share in these global resources.

Farming Was Always Thirsty Work

Arthur K. Flickinger, special coordinator,
Basin and Area Planning Division,
Soil Conservation Service

Irrigation, by transforming the parched western lands of the United States into productive cropland, helped to bind the East and the West together. Today, 30 percent of the value of U.S. agricultural production comes from the 12 percent of the farms that are irrigated.

The Biggest User

Agriculture is the Nation's biggest water consumer. Irrigated agriculture accounts for 42 percent of the average 310 billion gallons a day of freshwater withdrawn for offstream uses. Irrigated agriculture consumes almost three times the amount required by domestic, livestock, municipal, commercial, manufacturing, mining, and thermoelectric power users combined. (Water consumed is that returned to the atmosphere by evaporation or transpiration, incorporated in the plant or animal tissue or commodity produced, or that percolates beyond the area of reuse.) Irrigated agriculture consumes 78 billion gallons a day—74 percent of the 105 billion gallons a day total freshwater consumptive use of the Nation.

New Age of Irrigation

Irrigation in the United States began with the settlement of the arid West in the 19th century. Much earlier, however, Spanish explorers found irrigated agriculture already established in the Western Hemisphere—crops irrigated from stone aqueducts in Peru and from wide dug ditches in Mexico. Archaeologists have unearthed irrigation works used by North American natives centuries before the explorers arrived. As early as 100 B.C., the Hohokam Indians irrigated maize, beans, and squash near what is now Phoenix, Arizona. During the 16th and 17th centuries, the Spanish settlers and missionaries established modest irrigation works in the arid southwest. They introduced irrigation to such crops as grapes, fruits, vegetables, olives, wheat, and barley.

Mormon settlers began irrigation in the Salt Lake Valley of Utah in 1847. The Union Colony developed major irrigation systems near Greeley, Colorado in 1870. These early settlers used surface gravity methods to irrigate level lands along streams. The practice spread to California, Idaho, and then throughout the West. Great

Center-pivot sprinkler irrigation, developed within the last half century, is most popular in the Northern Plains and Eastern regions. (Tim McCabe, SCS, NE-2272)

Plains settlers began irrigating in the late 1800's, a time when the practice was rapidly expanding across the country.

Spreading Waters

The 1890 to 1910 great speculative boom in irrigation development began to spend itself, with expansion slowing during the teens. The amount of irrigated land remained nearly constant during the 1920's and early 1930's. Each census, since 1935 until 1982, however, marked an increase in acreage of irrigated land, increasing from 21 million acres in 1939 to more than 50 million acres in 1978.

The Census of Agriculture shows 1.8 million fewer irrigated acres in 1982 than in 1978. A followup survey shows a drop of another 4 million acres during the next 2 years. Fewer acres were irrigated because lowered water tables and higher energy costs markedly increased the cost of pumping water, and because commodity prices were lower.

Encouraged by Laws

Several Federal laws encouraged irrigation in the West. The Desert Land Act of 1877 granted land to homesteaders on the condition they irrigate. The Carey Act of 1894 granted land to States in the arid region under the same stipulations. The Reclamation Act of 1902 provided for Federal construction of irrigation works partly financed from the sale of public lands.

Establishment of the Bureau of Reclamation made possible large-scale irrigation enterprises beyond the financial capabilities of either State governments or private enterprise. The Department of the Interior's Bureau of Indian Affairs and Bureau of Land Management, the United States Army Corps of Engineers, and the Department of Agriculture also had program responsibilities for western irrigation development.

Sprinkler Systems

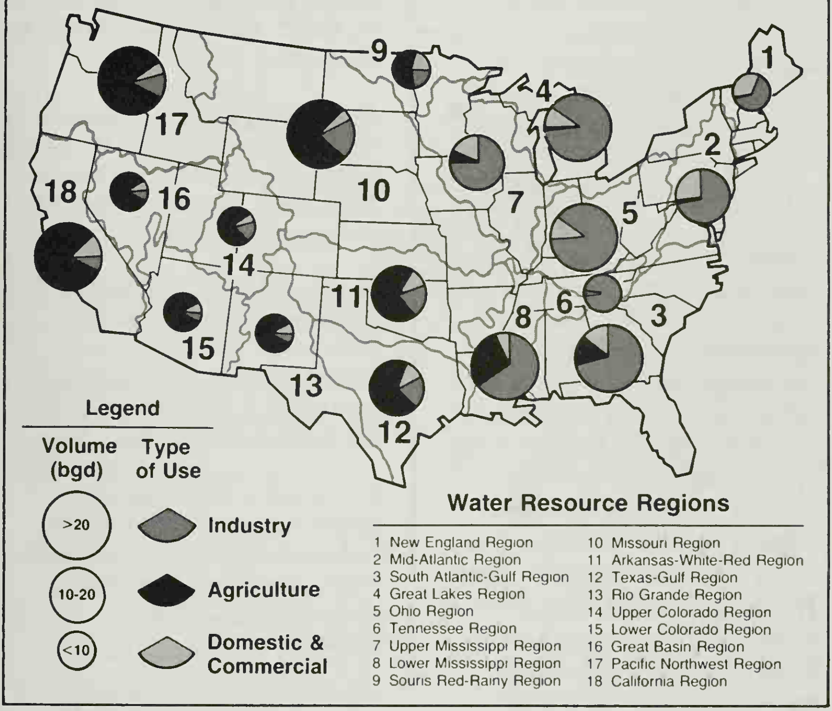
The development of deep-well drilling equipment and power-driven centrifugal pumps increased access to surface and ground water for private irrigation. This invited development and widespread use of sprinkler irrigation. Adaptation on sloping as well as flat land, sprinklers were used on 2 million acres in 1955 and 17 million acres in 1984. More than 40 percent of sprinkler systems are of the center pivot design.

Thirsty Crops

The irrigation requirement of a crop is the amount of irrigation water needed for transpiration, building of plant tissues, and evaporation from adjacent soil beyond that moisture already being provided by nature. The average crop irrigation requirement in the United States is 1.5 acre-feet of water an acre, ranging from a half acre-foot an acre in the cool, humid northeast and lake regions to over 3 acre-feet an acre in the hot, dry southwest. (An acre-foot equals 325,851 gallons.) The irrigation requirement also varies by crop: hay ranges from less than 1 acre-foot to over 3.5 acre-feet an acre

Siphon tubes divert irrigation water into furrows on a Colorado onion field. (Tim McCabe, SCS, CO-11,330)

Regional water withdrawals by functional use


1
2
3
4
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6
7
8
9
10
11
12
13
14
15
16
17
18
Legend
Volume (bgd)
>20
10-20
<10
Type of Use
Industry
Agriculture
Domestic & Commercial
Water Resource Regions
1 New England Region
2 Mid-Atlantic Region
3 South Atlantic-Gulf Region
4 Great Lakes Region
5 Ohio Region
6 Tennessee Region
7 Upper Mississippi Region
8 Lower Mississippi Region
9 Souris Red-Rainy Region
10 Missouri Region
11 Arkansas-White-Red Region
12 Texas-Gulf Region
13 Rio Grande Region
14 Upper Colorado Region
15 Lower Colorado Region
16 Great Basin Region
17 Pacific Northwest Region
18 California Region

per year; small grains such as barley and wheat range from 0.4 to 2.3 acre-feet; and row crops such as corn range from 0.5 to 2.2 acre-feet. Sorghum and beans generally use less water than corn.

Run-On and Runoff

On a hot summer day a few years ago, farmers diverted 200 billion gallons of surface water and pumped a like amount from ground-water sources to irrigate 49 million acres. During the year, 278,277 farmers withdrew 145 million acre-feet—an average of 129 billion gallons a day. Crops used 68.6 million acre-feet and incidental losses amounted to 18.8 million acre-feet; thus, net depletions accounted for 87.4 million acre-feet (60 percent) of the withdrawals. The remaining 57.6 million acre-feet (40 percent) returned to the stream system to become available somewhere downstream.

Although farmers irrigated nearly 20 percent more land in 1982 than in 1975, they used about the same amount of water. Rates of irrigation water use per acre were lower in 1982 because

(1) irrigated farming had shifted in part from arid to more humid regions, where precipitation fills much of the crops' water requirements;

(2) conveyance losses have been reduced by increased use of lined canals and onfarm water sources;

(3) onfarm distribution and application systems have been improved or new ones introduced—for example, laser-beam field leveling, surge-pulse irrigation, and drip systems; and

(4) irrigation water management is more sophisticated, making use of computer-aided scheduling, risk acceptance, and cost-reduction objectives.

Constraints on Use

Not enough water remains to sustain irrigated agriculture at current levels in 4 of the 18 water resource regions of the contiguous United States. Supply is the principle constraint to irrigation expansion in another 7 of the 18 water resource regions. Within the contiguous United States, 8 percent of the replenishable water supply is depleted. Depletion in the humid regions is less than the national average, but in the arid regions the percentage is so high that it approaches the total replenishable supply. Flows diverted for offstream uses deplete streamflows by more than 70 percent in 16 of the 99 subregions in the contiguous United States. An estimated 13 million of the 96 million acre-feet annual ground-water withdrawals are overdrafts (withdrawals in excess of recharge).

Nonagricultural water uses are expected to triple in the next 50 years.

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Rural Landscape—a Changing Heritage

Ronald W. Tuttle, national landscape architect,
Soil Conservation Service

America's rural landscape suggests to many of us an array of colors and forms, a rich diversity of open space and managed cropland, clusters of ranch or farm buildings, and small communities in harmony with their surroundings. But these patterns of rural land ownership are changing. Traditional farmsteads and farming practices are being consumed by urbanization with productive farmland lost and rural residents displaced. Farm consolidation, an increase in absentee landowners, and an economic crisis on many farms threaten rural America.

Different Perceptions of the Rural Landscape

One definition suggests that it is "a complex of ecological, economic, and cultural qualities on which a variety of life forms are dependent."[1] Another authority defines the rural landscape as beginning at the edge of town—"beyond the last street light and where the familiar asphalt ends."[2]

No two areas are alike. Any part of the rural landscape reflects its physical setting and the cultural meanings associated with it. Although most of us appreciate the rural landscape, we assign different values to it.

A rural landscape that is considered the traditional family home by many rural residents can provide a daily excursion or a weekend get-away to nonrural residents. Others value it as property to be managed and intended for production or for future development. Regardless of its specific value to any one individual, the uses assigned to the rural landscape affect all of us.

Characterized by a predominance of agricultural patterns that are interspersed with natural features, farmsteads, homesites, and rural communities, the rural landscape is a bountiful but finite resource. Valued for its productive capability, it also is a part of our cultural heritage.

Pace of Change Increasing

Entitled *The Face of Rural America,* the 1976 Yearbook of Agriculture was devoted to a visual record of America's agriculture in the Bicentennial year.

Earl L. Butz, Secretary of Agriculture at that time, was quoted in the Yearbook as saying, "Modern agricul-

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[1] American Society of Landscape Architects, *Policy on the Rural Landscapes,* 1985.

[2] Erwin H. Zube and Margaret J. Zube, *Changing Rural Landscapes,* 1977.

The dust, odor, and noise of farming often are sources of conflict with adjacent subdivision residents. (Tim McCabe, SCS, VA-5,277)

ture is changing so fast that it is hard to keep up. Those who used to live on the farm may have fond memories of those experiences, but if they are away from the farm for even a while, they quickly fall behind."

This rapid pace has not diminished in the decade since 1976. Complex economic and technological factors are causing current changes to occur more rapidly than in the past and often on a larger scale.

Agriculture's Historical Impact

Since its beginning in this country, agriculture repeatedly has changed the character of the rural landscape. The agriculture practiced by the settlers of the 18th and 19th centuries gave way to mechanized agriculture in the middle of this century.

The diverse mixed crop and livestock farming of the settlement era was soon replaced with the one- or two-crop, highly specialized farming enterprises found in many places today. Agriculture and the rural landscape may again be going through a fundamental change, which growing farm problems and urban encroachment have helped bring about.

Changes in the rural landscape may be quiet yet dramatic. New homes may suddenly appear in a pasture on which cows grazed a few months earlier. Other changes are less dramatic but equally significant; for example, a gradual loss of topsoil or subtle change in water quality easily can be overlooked. Highly effective conservation measures can be removed thoughtlessly with devastating results. Change is a continuing theme in the rural landscape, influenced by land use, technology, and farming practices.

Migration of the Affluent

Repercussions of land-use changes in the rural landscape are many and interactive. For example, existing rural residents are displaced when residential developments introduce urban-oriented people. Often affluent, these new residents may have a pastoral ideal of the rural landscape and not be prepared to cope with the reality of unpaved roads, farm chemicals, or the dust, odor, and noise of a farm enterprise.

A concentration of nearly uniform dwellings, paved streets, storage sheds, manicured lawns, and exotic vegetation replace the clustered farmstead buildings, indigenous vegetation and rural roads. The social and economic structure of the rural community is extricably altered.

National Agricultural Lands Study

In 1980, the *National Agricultural Lands Study* called attention to prime agricultural lands being converted to other uses. Whether this change poses a threat to the future adequacy of farmland acreage in this country has been broadly debated.

A disconcerting decrease in family farms and in experienced farmers is evident. Approximately 5 to 8 percent of all farmers in this country left farming in 1985.[3] Many of the farms they left were acquired by farm management companies or absentee owners who are isolated from the needs of the land or rural community.

Census data suggest that much of the recent rural population growth is within commuting distance of urban areas, but as far as possible into the rural fringe, which is also the area of fastest population growth. Currently, two out of five "rural" Americans are said to live in counties classified as metropolitan.[4] Many of these newcomers are interested in acquiring small tracts of land that they can manage as "hobby farms." Existing rural communities are transformed from a set of traffic lights, a local farm implement company, and a coffee shop into small cities with shopping malls, office parks, and bypass highways.

Farms Change Land Too

Changing farm technology and practices change land just as surely as the more obvious process of urbanization. Few individuals are likely to notice the ecological effects of agricultural chemicals or the new land patterns that a large farm operation necessitates. Such changes may seem insignificant, but in fact may change the ecology and landscape quality significantly.[5] A trend towards increas-

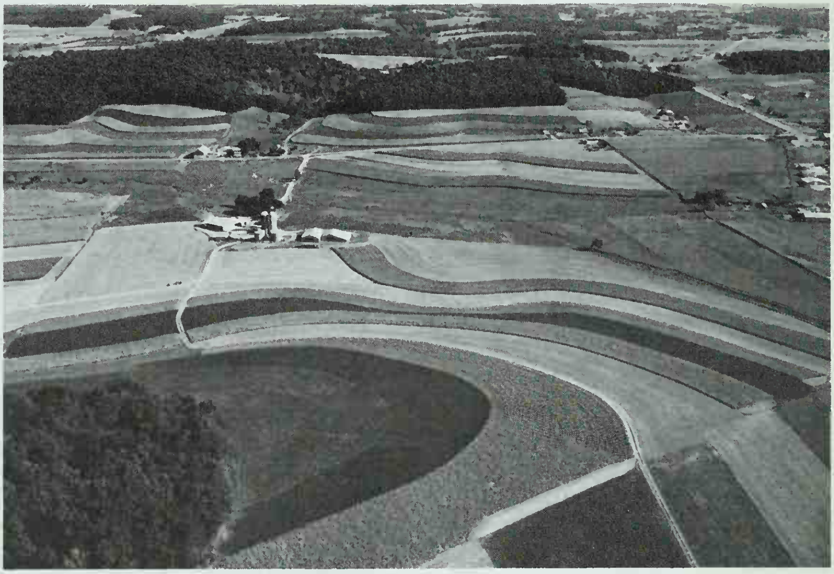
[3] *The Economist*, "On the Trail of the White Collar Settlers," 1986.

[4] *The Economist*, 1986.

[5] Duane Coen, Joan I. Nassauer, and Ronald W. Tuttle, *Landscape Architecture in the Rural Landscape*, American Society of Landscape Architects, Washington, DC, 1987.

Today's mechanized feeding and confinement facilities take animals out of the pastures and away from view. (SCS)

Farmers adjust crops to special market opportunities. These onions grow on muck soils in southeastern Wisconsin. (Dale Lange, SCS, WI-1536)



Contour stripcropping helps protect a Maryland farm from erosion, one of the ways rural landscapes can be conserved and still accommodate human needs and uses. (Tim McCabe, SCS, MD-30,622)

ingly large-scale farming with larger and more specialized equipment and production goals has caused farmers to increase field size and remove windbreaks, hedgerows, wetlands, woodland, and other features that give the landscape a special identity but impede efficiency.

New combines and similar equipment often require bigger machine shops, and other farmstead buildings are made obsolete by specialized handling and storage requirements. Instead of storing hay in enclosed structures, for example, many farmers now bale hay into large rolls that are left in the field until used.

Specialized Structures

Intensive husbandry of livestock now confines pigs, poultry, and grazing animals in specialized buildings with controlled environments where feeding and waste management require special attention. Blue silos, metal or fiberglass roofing, and prefabricated buildings reflect the use of standardized materials and structures in place of local materials and structures designed for specific needs and site conditions.

New farm buildings tend to be large, one-story structures with a clear span, high eaves, and clad in sheet material. Because of the large area dimensions of these buildings, their construction often results in substantial changes to the site on which they are located.

Consolidated farm holdings have

caused a redundancy of farmstead structures and a growing number of tenant farmers. When they are absorbed into larger ownerships, many farmsteads are abandoned or demolished for increased acreage to maximize the use of the land for profitable production. High-input technologies have increased the use of chemical fertilizers, herbicides, and pesticides. Their use causes concern for water quality and ecological systems.

What about the Future?

Predictions are only as good as the crystal ball being used and unadvisable at the best of times. This is especially true of predicting something as complex as the future rural landscape. With that in mind, there are a number of possibilities to ponder.

The current farm crisis and adjustments in the rural landscape have been widely publicized. Some experts suggest that agriculture and rural lifestyles are evolving into something fundamentally different. Responding to politics, economics, climate, and technology throughout the world, life in the rural landscape will become increasingly dynamic.

Consolidation of rural land ownership and businesses will result in additional large-scale commercial enterprises. At the same time, an increase of small-scale operations tailored to geographic conditions, special market opportunities, and individual preferences is likely. Future farmers, ranchers, business people, and rural residents will be innovators who look for alternatives to traditional methods and the resource information needed to make the alternatives successful. Sensitive to market conditions, they will be flexible in shifting to meet changing demands.

Protection vs. Usage

Environmental quality vs. resource potential will influence agricultural policy and rural activities. Interest in preserving glimpses of the rural past and present character are likely to grow. Farmers and others will be more inclined to adapt existing structures and equipment to meet ongoing and future needs. Biotechnology and other forms of emerging technology will introduce improved species and techniques that allow a greater tolerance to prevailing conditions and an independence from the use of farm chemicals. Advances in computer technology and automation will increase efficiency and provide more free time for rural residents.

Do We care?

The rural landscape will continue to change as people have new ideas. Before making changes, however, their effects on rural landscape values and quality of life should be understood and fully appreciated. Experience suggests that the rural landscape can be conserved and still accommodate human needs and uses. People, however, must care enough and be willing to accept the challenge.

Weighing Use Against Needs and Values

Marion Clawson, senior fellow emeritus,
Resources for the Future, Washington, DC

The use and management of forests, croplands, and grasslands is strongly affected by the available technology, the national economy, the international trade possibilities, and the population of the country. As these factors change, so will the use landowners and land users make of the land.

The building of the railroads, as the country was settled and developed, opened markets for farm and forest products and quickly led to changes in the way land was used. The steel plow, the grain binder, tractors, autos, and trucks each had their own major effects on land use. But so did electricity, telephones, radios, TV, and computers.

The increasingly productive U.S. economy gave ordinary people more income with which to buy farm and forest goods and to enjoy outdoor recreation. Landowners and land users could produce for increasingly affluent consumers.

Today U.S. landowners and land users are increasingly exposed to pressures of the world market. They must compete with producers in other countries while trying to expand markets abroad. The competition at home and abroad is often sharp but sometimes highly profitable for our producers.

And, of course, increased population has placed greater demands on our cropland, our grassland, and our forests.

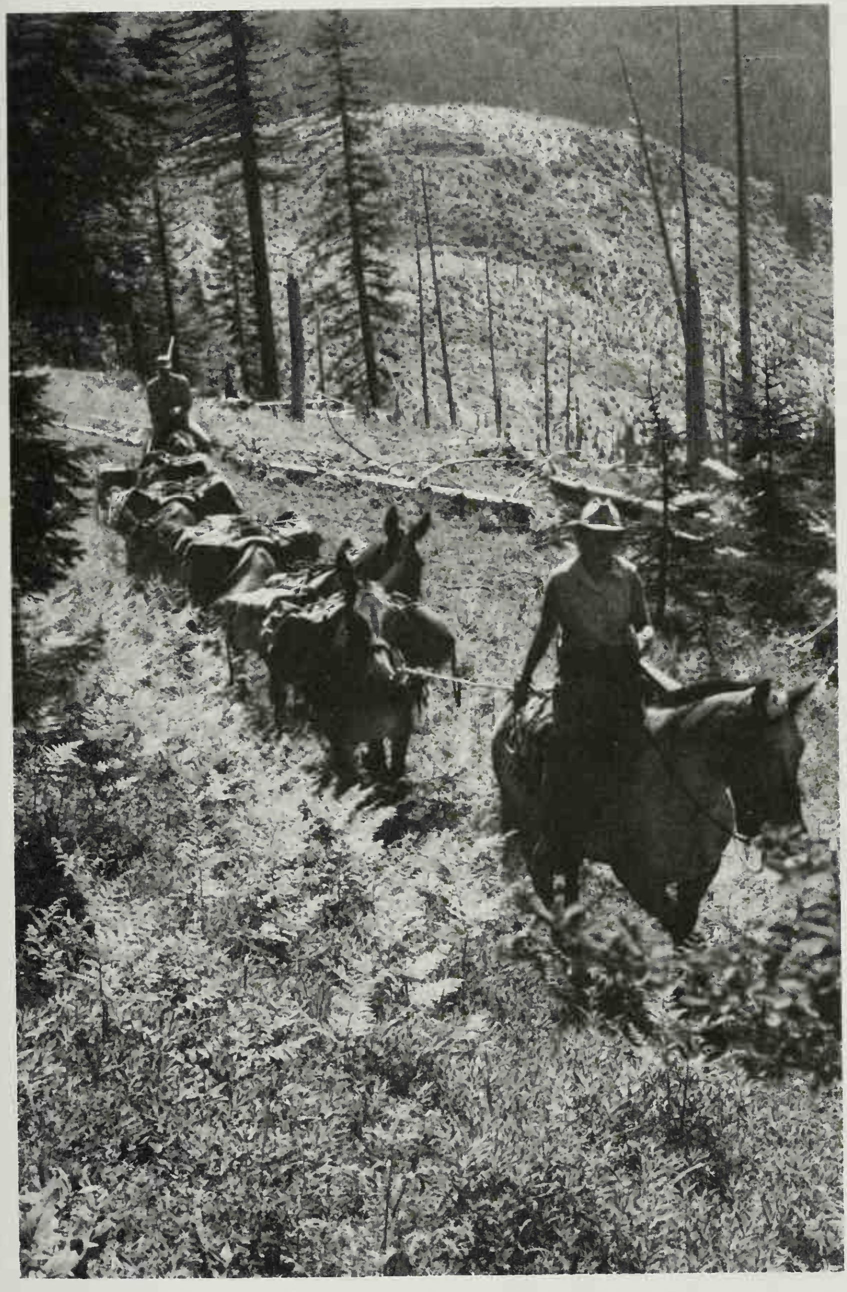
These influences have been indirect and yet powerful. Land user decisions and actions in turn are influenced, if not determined, by these indirect forces.

The early pioneer had to be self-sufficient, producing to meet family needs, while limiting consumption to what the land could produce. But the modern land user lives and operates in a larger world, subject to both greater opportunities and wider competition.

Virgin Land

The original colonists encountered vast forests, little cultivated crop production, and extensive grazing lands in the then remote West. The American Indians fully used all these resources within their own limitations. They used fire extensively. They hunted and fished, but they grew few cultivated crops, and their only domestic animal was the dog.

Most of the eastern half of the United States was forested and there



A pack string heads up Coffin Mountain in Oregon's Willamette National Forest. Coffin Mountain is home to recreation, timber activity, wildlife, and a fire lookout tower. (Sam Frear, FS) were extensive western forests as well. Much of the country is naturally forested in the sense that, if humans do not touch it, the land will grow back to trees and in time become heavily forested. Those early forests were essentially storage forests, that is, annual wood growth was matched by decay, with very large inventories of standing timber but little or no net growth.

These forests were a great asset to the early pioneers, because they provided building material and fuel close at hand. They were also a great problem, because, until the forests were cleared, cultivated crops could not be grown. With the simple tools available to pioneers, forest clearing was slow, difficult, and hard work. The pioneers also feared the forests, for it was from them that marauding Indians often came.

As settlement moved westward, prairies and then plains were encountered—natural grasslands. These grasslands supported wild animals in large numbers. The buffalo were particularly numerous. Estimates of their numbers before white settlement are as low as 4 million and as high as 100 million. No one then or now really knows how many buffalo there were. We can safely say: a great many. And there were other wild herbivores such as deer, elk, and antelope. But domesticated livestock were introduced by the settlers.

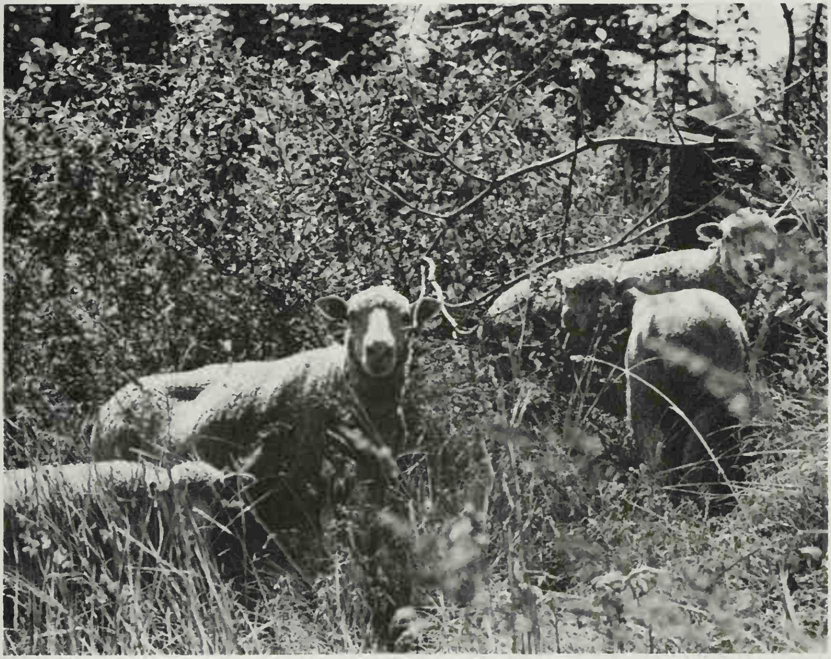
Forest

Over the past 200 years about half of the original forests have been converted to farms, cities, transportation networks, factories, and shopping malls. Much of the remaining forested area has been cut. Cutover areas often were burned repeatedly, to prevent tree regrowth, in the mistaken belief that the land could be made into productive farms.

A hundred years ago, and continuing for several decades, conservationists were concerned over the Nation's future timber supply. They underestimated the capacity of forests to regenerate themselves. The rate of regrowth of a forest can be impressive, especially in the South. The annual growth of wood today is at an all-time high. It is still not much more than half of its potential if intensive management were applied to all U.S. forest land.

The forests have won back some of the land they once surrendered to farming. In the Northeast, in the hill country and across much of the South, extensive forests stand where there were farms a few decades ago.

The forests now produce large volumes of wood annually, which is converted into lumber, plywood, paper, and products essential to our modern economy. But they do far more than that. They are the home of much wildlife, which we value highly; they are watersheds from which streams flow; and they provide outdoor recreation and other services enjoyed by millions of people. The publicly owned forests are generally managed for multiple uses, but even the privately owned forests produce many kinds of outputs.



Sheep graze on understory in a Colorado National Forest. (FS)

Cropland

The croplands were created by clearing the forests and plowing the prairies and plains. Millions of settlers struggled over decades to convert stubborn and unresponsive land to productive farms. Each settler used the best and most readily available land. Many areas were cleared and farmed briefly, only to be abandoned as more productive lands were located with which to supply the markets more cheaply. This abandonment has been the source of much of the forest recapture of land in the past generation or longer.

For nearly two generations cropland area has been relatively stable. While newly cleared land has been added, other farmland has reverted to trees or grass. Total areas have remained fairly constant.

What has changed and continues to do so is the greatly increased output of crops and livestock from this roughly constant cropland area. Total output has doubled or more since the Nation was founded. This tremendous production has been the result of the scientific revolution in American agriculture, to which the agricultural colleges and the U.S. Department of Agriculture have been major contributors.

The greatly increased agricultural output from a relatively constant land area closely parallels the increased wood growth from an also relatively constant forested acreage. But the park and recreation areas of the country also accommodate vastly larger numbers of visitors on land areas that have not kept pace with their increased public use.

Grasslands

Domestic livestock was always being grazed on native forage plants along the frontier of settlement. But it was after the Civil War that ranching expanded with explosive rapidity to the Great Plains and the West beyond.

Much U.S. land will produce grass or other plants edible by livestock, but in low yields making mechanical harvesting or cultivated crop production impossible. On such land plant growth can be harvested economically only by animals grazing it. Although the yield is low, output from the extensive grazing lands can be great. Moreover, by use of large areas of such land, ranchers can produce a large output per employee.

Ranching is an efficient form of production of a desired meat output from lands of low productivity per acre. But it is also a way of life that many find attractive.

Land for Other Uses

Crops, forests, and grass are the "big three" of land uses, with about 90 percent of the national land in these uses. Land used for cities and towns, factories, shopping malls, highways and airports, and other specialized uses competes with each of the "big three." But all these other uses will never challenge the vastness of forests, fields, and grasslands.

America Discovers Its Wilderness

Dennis Roth,
chief historian,
Forest Service

Until the early 20th century, wilderness survived only as a byproduct of the movement to reserve public lands for other purposes. Then the Forest Service began experimenting in Federal wilderness management in the early 1920's.

Arthur Carhart, the agency's first landscape architect, helped preserve the Trappers' Lake Region in Colorado from development, and Aldo Leopold, in 1924, created the Gila Wilderness in New Mexico, the first official wilderness area in the United States.

Wilderness Inventory

Chief Forester William Greeley ordered inventories of all undeveloped National Forest lands larger than 230,400 acres in 1926. Soon after, rules were established for managing "primitive areas." By the mid-1930's the agency had designated nearly 14 million acres of primitive land.

The leading advocate of wilderness preservation in the 1930's was Bob Marshall, who in 1937 became head of Recreation and Lands for the Forest Service. In 1939 Chief Forester Ferdinand Silcox approved Marshall's plan to inventory, study, and reclassify primitive lands as wilderness areas to provide them greater protection.

Marshall died a young man of 38 in 1939 with the reclassification hardly begun.

Growth of National Organizations

During World War II the Forest Service's primary job was to supply wood for the war effort. After the war, the booming economy made many demands on National Forest resources. The leadership in wilderness preservation began to pass to private organizations such as the Sierra Club and The Wilderness Society.

Several Federal actions were a blow to wilderness advocates, including a proposal by the Bureau of Reclamation to construct a dam in the Dinosaur National Monument in Utah administered by the National Park Service. It was defeated in 1955, but the struggle mobilized the wilderness organizations to push for a bill creating a national wilderness system.

Wilderness Legislation

The first wilderness bill was introduced in 1956 by Senator Hubert

In the 1930's, Bob Marshall of the Forest Service recommended reclassifying some primitive areas as Wilderness Areas, giving them greater protection. (FS)

Humphrey of Minnesota. During the next 8 years the campaign to pass the bill was led by Howard Zahniser, executive director of The Wilderness Society. The bill was strongly opposed by interests that did not want to see millions of acres of public land permanently "locked up." The Forest Service and the Park Service initially opposed the bill, but by 1960 had become active supporters. After much debate and compromise, the Wilderness Act was passed and signed in September 1964.

Wild and Scenic Rivers Act

Congress passed the Wild and Scenic Rivers Act in 1968 to preserve portions of 50 rivers on Federal land in their free-flowing state. Many additions to this system followed.

The Wilderness Act transferred 9 million acres of National Forest wilderness land into the wilderness system and required review of the 5 million acres of remaining primitive land for possible inclusion. Beyond the scope of the Wilderness Act were millions of acres of undesignated but undeveloped land in the National Forests that were also potential wildernesses.

The Multiple Use-Sustained Yield Act of 1960 required the Forest Service to consider wilderness use in its general planning for the National Forests. The wilderness organizations urged the agency to recommend to Congress many other areas, in addition to the primitive areas, for wilderness designation. The Forest Service would have preferred to finish its review of primitive areas first.

Eastern Wilderness Areas

Almost all the eastern National Forests had been created from cut-over and partially roaded land and, although many of the forests had grown back, none of them were as pristine as the forests of the West. The Forest Service wanted to create a separate "Wild Areas" System in the 1970's for eastern areas, arguing that the Wilderness Act did not allow inclusion of cut-over areas.

The Wilderness Society argued for the designation of eastern wildernesses. The Society had considerable public support and in 1974 secured passage of the so-called Eastern Wilderness Act which designated areas in the National Forests of the Northeast, South, and Midwest.

Endangered American Wilderness Act

After this victory, the wilderness organizations turned to the West where the Forest Service had not recommended some areas because they were too close to urban areas. This involved the so- called "sights and sounds" criteria, an offshoot of the "purity doctrine." In early 1978 the wilderness organizations again won when the Endangered American Wilderness Act was passed placing more than a million acres of land, much of it near several western cities, into the Wilderness System.

RARE I

Throughout the 1970's the Forest Service sought to regain control over the process of wilderness designation and share leadership in the field of wilderness preservation. In 1971 the agency announced a plan to study roadless areas throughout the National Forest. This effort became known as the Roadless Area Review and Evaluation or RARE (later RARE I when RARE II began). It was an attempt to resolve the wilderness conflict on a nationwide basis by recommending some areas for wilderness designation while opening others to potential development.

The Sierra Club, however, sued the agency for not complying with the procedures of the National Environmental Policy Act. In an out-of-court settlement the Forest Service agreed to conduct site-specific environmental impact studies before opening any roadless area to development. RARE I was the first extensive nationwide study of potential wilderness areas.

RARE II

In 1977, with the roadless area issue at an impasse, Rupert Cutler, the Assistant Secretary in charge of the Forest Service, announced an even more comprehensive study known as RARE II. During the next year and a half the Forest Service studied 63 million areas of roadless land or approximately one-third of all National Forest land. The agency then recommended that 15 million acres be designated as wilderness, 11 million be studied further, and 36 million be released for possible development. These recommendations were not completely acceptable to anyone, with the wilderness organizations the most vociferous critics.

Congressional Actions

In 1980 Congress followed the RARE II recommendations on a state-by-state basis, passing bills for Colorado, New Mexico, and Alaska, as part of the Alaska Lands Act. These bills created some wilderness areas, left others to be studied further, and released the rest for possible development during the 10- to 15-year lifetime of the individual forest plans being written under the terms of the National Forest Management Act of 1976. After that, the Forest Service could again study likely areas for wilderness designation if they had not been developed in the meantime.

Debate over Release

After the Presidential election of 1980, the timber industry pressed for a bill authorizing permanent nationwide release of wilderness areas. The environmental organizations responded by demanding retention of the so-called "soft release" formula used in the Colorado bill. Consequently, wilderness bills for the large western States were held up in congressional committees for 3 years.

Complicating this was the petroleum industry's attempt to lease oil and gas sites in some wilderness areas before the expiration of the December 31, 1983 deadline. The Secretary of the Interior, who controlled the leasing of mineral rights on public lands said he had no choice but to allow leasing in wilderness areas.

Faced with public outcry over the prospect of oil rigs in famous areas such as the Bob Marshall Wilderness in Montana, Congress passed a ban on such activity. Although not directly related to the release issue, this struggle showed strong public support for wilderness and increased the pressure on Congress to pass wilderness legislation.

By late 1983 Senators Dan Evans of Washington and Mark Hatfield of Oregon were anxious to pass bills for their States. They urged the Senate Energy and Natural Resources Committee to pass out their bills containing "soft release."

In April of 1984 James McClure of Idaho, Chairman of the Senate Energy Committee and supporter of the timber industry's position, and John Seiberling of Ohio, Chairman of the Public Lands Subcommittee of the House and champion of the environmentalists' cause, agreed on new language to break the release deadlock. Basically the soft release formula was retained.

The flood gates opened, and 18 wilderness bills were passed affecting nearly 7 million acres, the biggest single increase in the National Forest portion of the Wilderness System since the Wilderness Act of 1964. The Forest Service's RARE studies gave environmentalists and politicians the information they needed to make decisions.

Understanding Land

Part III

Mapping Ecoregions To Manage Land

Robert G. Bailey, geographer,
Land Management Planning Staff,
Forest Service

Knowing how the biological and physical components of land are integrated to form ecosystems is basic to understanding its productive value. This integration can be evaluated with precision for small parcels of forested or agricultural land called sites. However, strategic planning of large areas calls for grouping the sites into ecosystem regions or *ecoregions.* This requires differentiating between spatial patterns of sites.

Ecoregions' Value to Management

Ecoregions are useful to land managers in two ways. First, a map of such regions suggests the area to which the knowledge gained in studing the ecosystem behavior can be applied. Second, they provide a geographical framework for identifying other similar areas from which similar responses may be expected and similar management policies applied. This facilitates a regional rather than site-by-site approach to planning land use. The need for environmental inventories and analysis is correspondingly reduced.

Mapping Ecoregions

Ecosystem regionalization is the delineation of large units of land according to the ecological relationships among neighboring ecosystems. A boundary is placed around groups of related ecosystems that show similarities in both appearance and structure. They are influenced by the same climate and soil conditions. Groups of spatially related ecosystems can be considered an ecosystem of higher order and is usually larger—a macroecosystem.

Ecoregions often differ in size and can be ranked by levels of detail. A hierarchy of boundaries enables scientists to view the Nation's environment with greater and greater resolution as they move down the map scale. All components of an ecosystem are not equally significant at defining ecoregions in the hierarchy.

Climatic Factors

Climatic factors determine the boundaries of ecoregions to a considerable extent. The most important of these factors is the climatic regime, defined as day by day and seasonal fluxes of energy and moisture. As these change, so do kinds and patterns of dominant plants and animals, as well as the kinds of soils. The most important consideration in identifying ecoregions is to recognize significant differences in climate by looking for the following:

1. The series of ecosystem regions should express the changing nature of the climate over large areas. Unfortunately, climate changes within short distances because of variations in local landform features and the vegetation that develops on them. So it is necessary to look for a climate that hierarchically lies just above the local modifying irregularities of landform and vegetation. These macroclimates are shown on maps of broad climatic regions. They outline ecoclimatic zones within which are groups of related ecosystems of importance to the climatologist in determining ecoregion boundaries. Other visible and tangible expressions of climate such as vegetation are also used to locate boundaries.
2. The composition of the vegetation of the ecosystem region changes with time in sequence from pioneer vegetation through intermediate steps to the most stable climax state. The climax plants are used to characterize regions because they are more site-specific than pioneer types, which may occur over a wider range of conditions. Each ecoregion comprises both the climax communities and all successional stages within its geographic area including freshwater communities.
3. Landform (with its geologic substrate, surface slope, and relief) modifies macroclimate to local climate. Sites to consider in regional delineation should be reasonably uniform sets of uplands, with well-drained surface, moderate surface-slope, and well-developed soils. In this way, the landform differences are screened out, leaving the biologically effective climate as the main variable between regions. These sites are typical of the ecoclimatic zones and are referred to as zonal ecosystems; the others are azonal.
4. Where ecosystems cover large areas, in a fairly uniform way, mapping is not difficult. Simplifying mountainous ecosystems into regions on the other hand presents problems. One approach is to look at these as a sequence of altitudinal zones. Each part of a mountain range with the same sequence is a distinct ecological unit. These units correlate with the distribution of the lowland climatic zone within which the range is located.
5. The mosaic of ecosystems found in major transitional zones (ecotones) also should be delineated as separate regions.
6. The boundaries of ecoregions can be located best by studying spatial coincidences, patterning and relationships of climate, vegetation, soil, and landform.

Useful scales for mapping ecosystem regions may be from 1:30,000,000 to about 1:3,000,000.

A National Map

A mapping project was begun by the Forest Service in 1976 with the support of the U.S. Fish and Wildlife

A variety of ecosystems form this region of sand dune, rock, and shrubland sites in the Colorado Plateau, a highland in the semiarid steppe zone. (John S. Shelton)

Service's National Wetland Inventory. It delineates successively smaller ecoregions within larger regions on an ecoclimatic basis. At each successive level, a different aspect of the climate and vegetation is assigned prime importance in the placing of map boundaries.

How To Understand Map

Four ecological levels defined by their climate and vegetation are shown. The broadest levels or domains are based on observable differences developed largely because of prevailing climatic conditions. Domains are broken down further into divisions based on dominant climax plant formation, and these geographically subdivide into provinces. Provinces subdivide into sections that differ in the floristic composition of the climax plant formation. Highland provinces and sections are distinguished where, as a result of the influence of altitude, the climatic regime differs substantially from adjacent lowlands to cause complex vertical climate-vegetation-soil zonation.

The hierarchical system begins with the country's 3.3 million square miles divided into four domains: Polar (15 percent of the U.S. land area), Humid Temperate (53 percent), Dry (31 percent), and Humid Tropical (less than 1/2 percent). These subdivide into 12 divisions, in total containing 30 provinces, in turn containing 45 sections.

This map presents twice the detail

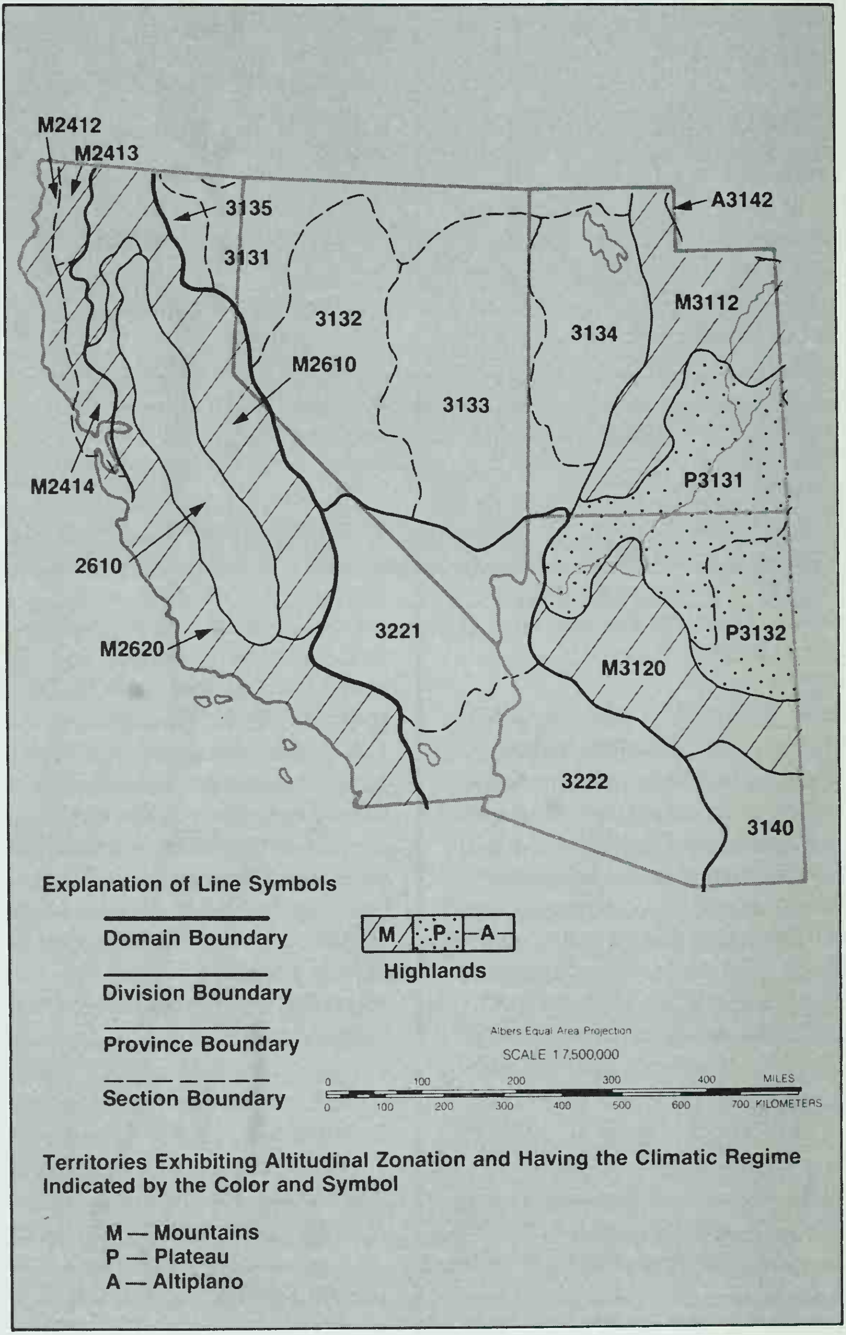
of previous maps of ecological regions. Using existing maps of climate, vegetation, soil, and landform as source material, it delineates ecosections in the United States encompassing more than 4,300 square miles.

At the province level, however, the more comprehensive ecological descriptions are found. Land-surface form, climate, soils, vegetation, and fauna are listed, along with the total land area and general geographic location. Sections within each province are listed by name and also indicated by number of the ecoregion map. For example, the redwood forests of northern California are in the Humid Temperate Domain, of the Marine Highlands Division, of the Pacific Forest Province, in the Redwood Forest Section.

Use

This map can be used for applying ecological and land-use information within ecoregions. Because the map is ecologically based, any ecological data and information can be safely applied to similar sites within the region, e.g., silvicultural practices, estimates of forest yields, and seed use. Experiences concerning land use such as terrain sensitivity to acid rain, suitability for agriculture, and effectiveness of best management practices in protecting fisheries can be applied to similar sites with each region.

The map provides an integrated geographical framework for use by Federal and State agencies throughout the country. It has been adopted by Federal agencies. National programs and studies using it include the National Wetlands Inventory, Acid Precipitation Trends Network, Management of Transmission Line Right-of-Way for Fish and Wildlife, Water Resources Evaluation of Non-point Silvicultural Sources, and Habitat Suitability Index Models. The Forest Service has used the map in assessments of forest and range lands required by the 1980 Resources Planning Act and in the Roadless Area Review and Evaluation (RARE II) Program. The National Oceanic and Atmospheric Administration has incorporated the ecoregion code into its national environmental data base. The map has been expanded to include the rest of North America. It also has been proposed as a model from which to create a world ecoregions map to serve as a reporting structure for information about global resources and environment.


M2412
M2413
3135
3131
3132
M2610
3133
3134
A3142
M3112
P3131
M2414
2610
M2620
3221
P3132
M3120
3222
3140
Explanation of Line Symbols
Domain Boundary
Division Boundary
Province Boundary
Section Boundary
M
P
A
Highlands
Albers Equal Area Projection
SCALE 1:7,500,000
0 100 200 300 400 MILES
0 100 200 300 400 500 600 700 KILOMETERS
Territories Exhibiting Altitudinal Zonation and Having the Climatic Regime Indicated by the Color and Symbol
M — Mountains
P — Plateau
A — Altiplano

Explanation of numeric codes on part of the Ecoregions Map of the United States

2000 HUMID TEMPERATE DOMAIN

- 2400 Marine Division
- Highlands*
  - M2410 Pacific Forest Province
    - M2412 Redwood Forest Section
    - M2413 Cedar-Hemlock-Douglas-fir Forest Section
    - M2414 California Mixed Evergreen Forest Section

- 2600 Mediterranean Division
  - 2610 California Grassland Province

- Highlands*
  - M2610 Sierran Forest Province
  - M2620 California Chaparral Province

3000 DRY DOMAIN

- 3100 Semiarid Steppe Division
  - 3130 Intermountain Sagebrush Province
    - 3131 Sagebrush-Wheatgrass Section
    - 3132 Lahontan Saltbrush-Greasewood Section
    - 3133 Great Basin Sagebrush Section
    - 3134 Bonneville Saltbrush-Greasewood Section
    - 3135 Ponderosa Shrub Forest

  - 3140 Mexican Highlands Shrub Steppe Province

- Highlands*
  - P3130 Colorado Plateau Province
    - P3131 Juniper-Pinyon Woodland + Sagebrush-Saltbrush Mosaic
    - P3132 Grama-Galleta Steppe + Juniper-Pinyon Woodland Mosaic

  - A3140 Wyoming Basin Province
    - A3142 Sagebrush-Wheatgrass Section

- 3200 Arid Desert Division
  - 3220 American Desert (Mojave-Colorado-Sonoran) Province
    - 3221 Creosote Bush Section
    - 3222 Creosote Bush-Bur Sage Section

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*Key to letter symbols: M = mountains; P = plateau; A = altiplano

Working on Land by Hydrologic Unit

Stephen F. Black, assistant state conservationist,
and John J. Eckes, state conservationist,
Soil Conservation Service, Champaign, IL

The Association of Illinois Soil and Water Conservation Districts (SWCD) adopted the hydrologic unit or watershed as their basic planning area for soil and water conservation in 14 pilot counties in 1985. A policy statement on resource planning by hydrologic units followed in 1986 after which all of the State's SWCD's were encouraged to use this approach.

People in Illinois are working on soil erosion, water quality, farmland protection, land-use changes, water supply, flooding wildlife habitat, and socioeconomic issues. The hydrologic area or watershed, they find, is the best unit of land to use when evaluating conservation alternatives at the field, farm, or regional level. Likewise, it is a useful area for addressing issues about critical soils, mined land, drainage, or irrigation.

The Illinois Soil Conservation Service delivers services to land users by hydrologic area. This approach is good for comprehensive planning, organizing the delivery of services and reporting, and can be coordinated across county lines when applicable.

The base map for the hydrologic unit system uses the major river basins of Illinois as identified by the Water Resources Council and the U.S. Geological Survey. These 51 river basins are subdivided into additional units ranging from 15,000 to 250,000 acres, resulting in approximately 450 subunits. They serve as the base map system for coordinating all multicounty watersheds in the State and as a starting point for each county (SWCD). The size and boundary of each county subunit is determined locally. Criteria for developing county hydrologic units include:

- Community and landowner priorities and interests.
- Potential offsite public benefits.
- Other resource concerns.
- Existing and potential project activities.
- Size (40,000 acres, maximum)
- Number of farms (100 farms manageable).
- Coordination with adjoining counties along hydrologic unit boundaries.

Establishing Priorities

After county hydrologic units are identified, the SWCD board sets priorities for assisting each of them. These are based on the potential benefits; the extent of erosion in terms of the Illinois Erosion and Sediment Control

Landscape management on a watershed uses contour farming, stripcropping, terraces, and stream impoundments to conserve soil, create wildlife habitat, and improve recreation. Because hydrologic units are ecologically integrated, management of any part affects the whole system. (Tim McCabe, SCS)

Guidelines; the extent of highly erodible land subject to the conservation provisions of the 1985 Food Security Act; and the willingness of local people to act on resource projects that require attention. Approximately 2,000 small hydrologic units are in Illinois with an average of 20 units in each county. SWCD's have set priorities on over 200 units with additional units being added all the time.

As priority areas are selected, technical assistance is allocated to prepare a resource plan for the unit. Planning involves the landowners and the hydrologic unit steering committee. The planning committee decides strategy and maintains grassroots control.

As the planning committee identifies needs, they request technical assistance from appropriate Federal, State, and local agencies, and organizations. SWCD is a clearinghouse for these requests and sets the priorities for agency responses. A technical advisory committee may be set up to support the planning committees.

Resource Planning

Resource planning by hydrologic area helps local decisionmakers in measuring offsite, as well as onsite, benefits of conservation alternatives. Offsite benefits often are spread over a wide area and are difficult to measure in economic terms.

The Mercer County, IL SWCD was one of the first to adopt the system. They identified 37 hydrologic units and began planning in nine units within the first 2 years. Priorities have been set in six units and local planning committees established. Pat McVeigh, Chairman of the Mercer County SWCD says, "Committee members have a great impact on motivating other land users. The planning process gives people an opportunity, that is not otherwise available, to become involved and contribute."

Planning Advantages

Illinois SWCD directors have compiled the following list of advantages of hydrologic unit planning over other approaches:

- Local people identify resource concerns, outline goals and objectives, and develop strategies.
- Local participation leads to broad support for the plan and accelerates doing the job.
- A framework is provided for measuring offsite benefits on a scale that relates to local concerns and perceptions.
- A framework is provided for reaching audiences with common interests.
- Support and leadership is broadened for soil and water conservation programs in a county or region.
- A logical method of prioritizing needs and managing field office operations is provided.
- Close interaction with all agencies and organizations interested in resource conservation and land management is permitted.
- Efficiency is increased.

Recording Progress

A progress reporting system is used statewide to report annual accomplishments to SWCD and hydrologic unit planning committees. All work is coded to the specific county hydrologic unit. Summary reports can be prepared from this for any unit or incorporated with reports on larger hydrologic units or major river basins. Technology for measuring onsite and offsite benefits now includes the use of models. Models can take into account before and after erosion rates, sediment delivery and transport, pesticide, and nutrient loadings, and many other factors that would be too complex to calculate by conventional methods.

As microcomputers become available in agency field offices, progress reporting and benefit measurement are enhanced. Automated data bases and landowner records are maintained on a county hydrologic unit basis. Models are being developed to use the existing resource data and predict benefits based on the conservation accomplishments in each unit.

Paying for Progress

Working with hydrologic units dramatizes the fact that a farmer's conservation practices are of benefit to the vast society that lives downstream, between the farm and the ocean. Conservation treatment on private land that provides mostly public benefits may require some public contribution. Many local units of government in Illinois now provide funding for conservation programs for this very reason.

Some of the World's Best Farmland Is Here

Bobby T. Birdwell,
national leader for soil technology,
Soil Survey Division, Soil Conservation Service

Soil quality is determined by its properties, characteristics, and conditions. The best soils for field crops are nearly level, loamy, deep, fertile, and have a high available water capacity. The tilth of the tilled layer permits water to enter the soil readily, prevents crusting, and makes tillage easy.

The worst soils for field crops are strongly sloping, clayey, shallow, infertile and have low available-water capacity. Tilth of the surface layer is poor which leads to low infiltration, increased runoff and erosion, crusting, and higher energy requirements to till.

Only 7 percent of the Earth's land surface is suitable for cultivation—the rest is either too hot, too cold, too salty, too steep, or too stony. About 50 percent of the contiguous United States is suitable for cultivation.

Land Classes

The U.S. Department of Agriculture's Land Capability Classification was developed in the 1930's. It groups soils into eight capability classes primarily by their capacity to produce common crops and pasture plants without soil deterioration over a long period.

Class I: Soils with few limitations that restrict use.

Class II: Soils with some limitations that reduce the choice of plants or require moderate conservation practices.

Class III: Soils with severe limitations that reduce the choice of plants or require special conservation practices.

Class IV: Soils with very severe limitations that restrict the choice of plants or require very careful management.

Class V: Soils with little or no erosion hazards but with other limitations such as frequent flooding that restrict their use largely to pasture, rangeland, woodland, or wildlife habitat.

Class VI: Soils with severe limitations that make them generally unsuited to common cultivated crops and restrict their use largely to pasture or range, woodland, or wildlife habitat.

Class VII: Soils with very severe limitations that make them unsuited to cultivated crops and restrict their use to pasture or range, woodland, or wildlife habitat.

Class VIII: Soils with limitations that restrict their use to recreation, wildlife, water supply, or to esthetic purposes.

Prime farmland is the best land for producing crops. It has the right combination of physical and chemical properties, soil quality, growing season, and moisture supply. Like this Nebraska farmland, it is flat and available for growing crops. (SCS)

The best soils for field crops are loamy, deep, fertile and have a high water capacity. This soil profile shows a prime farmland soil in Osaye County, Kansas. (SCS)

Non-Federal Lands in the Contiguous United States by Land Capability Class

Class	Acres
I	36,030.0
II	290,810.2
III	288,507.5
IV	186,725.8
V	33,657.9
VI	265,096.8
VII	280,779.3
VIII	27,147.5
Total	1,497,655.6

Source: 1982 National Resources Inventory

Using capability class, the broadest category in the classification system, as an indicator of cropland quality, the contiguous United States has more than 615 million acres of land in classes I, II, and III.

Prime Farmland

Prime farmland is yet another indicator of quality. The best land for producing food, feed, fiber, forage, and oilseed crops, prime farmland has the right combination of physical and chemical properties for producing crops. It must also be available as farmland and not under urban development or other construction.

Prime farmland has the soil quality, growing season, and moisture supply[1] needed to economically produce sustained high yields of crops when properly treated and managed.

Soil surveys and land use/cover inventories are used to determine the location and extent of prime farmland in individual soil survey areas.

Soil Quality Indicators

Crop Yield. Soils support and sustain plants throughout the growing season. Crop yields from different soils are good indicators of quality. Yields of 160 bushels per acre of corn are common on Alpha silt loam, 1–3 percent slopes, but Beta silty clay loam, 2 to 5 percent slopes, in the same field and under the same management, yields only 85 bushels per acre.

Soil properties, husbandry, and other conditions contribute to differences in yields. Productivity-indices (PI) rank soils as to their productivity. PI's summarize the combined effects of major soil properties, characteristics, and conditions that influence yields in a particular region.

Soil Potential. Soil behavior can be improved by modifying the soil or by applying technology that improves its performance for a specific use. Soil potential classes—high, medium, low—express the relative quality of a soil for a particular use compared with other soils in the same area. Soil potential estimates address yield or performance level, the cost of applying technology to compensate for inherent limitations.

Determining Soil Resiliency

Soils vary markedly in their ability to bounce back to a prior condition after being misused or abused. Land

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[1] Specific criteria are contained in 16 U.S.C. 590a-f, g, i 7CFR 675.5

Cropland, Pastureland, Rangeland, and Forest Land by Land Subclasses.[1]

Land Subclass	Cropland	Pastureland	Rangeland	Forest Land	Total
			1,000 acres		
E	214,670	77,955	208,842	171,532	673,999
S	108,348	29,759	22,082	80,765	240,954
W	39,834	17,631	95,748	92,179	245,392
C	23,289	1,026	13,222	612	38,149
Total	386,141	126,371	339,894	345,088	1,197,494

[1] Does not include land in capability classes I or V which do not have subclasses.

Source: 1982 National Resources Inventory

Estimated Average Annual Erosion (sheet, rill and wind) in Relation to Tolerance Level (T)

Land Use	≤T	T-2T	>2T	Total
		1,000 acres		
Cropland	236,006	88,637	96,760	421,403
Pastureland	121,784	5,589	5,937	133,310
Rangeland	336,386	25,699	43,821	405,906
Forest Land	370,364	9,773	13,577	393,714
Total	1,064,540	129,698	160,095	1,354,333

Source: 1982 National Resources Inventory

subclass, a component of the Land Capability Classification, can be useful in determining resiliency. The subclass is a grouping of soils according to kinds of limitations and hazards associated with use. Four general limitations are erosion (e), root-zone (s), wetness (w), and climate (c).

Erosion. Erosion affects resiliency through the removal of surface soil. Although its impact is not equal for all soils, resiliency is diminished, more or less, by each erosive event. Deep, friable, loamy soils have perhaps the greatest potential long-time resiliency, whereas shallow, firm, clayey soils are slow to recover. Moreover, their ability to respond may be significantly diminished with each successive loss of top soil.

In an attempt to quantify soil loss and relate it to soil productivity, USDA soil scientists have assigned a soil loss tolerance, T value, for most cultivated soils. A T value is the maximum rate in tons per acre per year, at which soils can erode and sustain economical crop productivity over a long. Although a single T value is assigned to each kind of soil, a lower T value may be, and commonly is, assigned to portions of a soil on which erosion has significantly reduced the effective root-zone. Should erosion continue unabated, resiliency would be effectively reduced. Using T value as an indicator of resiliency, those lands exceeding tolerance levels provide a hint of the amount of reduced resiliency caused by erosion.

Resiliency on about 78 percent of all land remains relatively high, since that amount is eroding within tolerable limits. The resiliency of soils in cropland is slowly, but surely, being reduced.

Wet Soils. Wet soils are saturated, flooded, or ponded long enough during the growing season for anaerobic conditions to develop. Nature tends to match these hydric soils with "water-loving" vegetation. The result is wetlands that have their own unique set of characteristics. Our American land includes about 144 million acres of hydric soils. If drastically altered by drainage or by filling in, the ecology of a site is changed from a wetland to another land condition or use.

Fragility. Fragile soils are damaged easily through misuse or abuse. The degree of fragility depends on the soil's nature and properties and on the type and severity of the disturbance sustained.

Soils in hot or cold, and dry climates are in land capability subclass "c." These soils are generally in "equilibrium" with their environment and are very sensitive to induced changes. A good example is the extensive conversion of rangeland to wheat production in the Great Plains during the 1930's drought that resulted in the infamous Dust Bowl. Sudden, dramatic natural changes, such as fire, may so degrade sensitive forest soils and environments that regeneration is unlikely.

The concept of fragility extends to soils that are not in subclass "c." Soils shallow over hard sandstone on gentle slopes are more fragile than deep soils over limestone on gentle slopes. Similarly, shallow soils on steep slopes are more fragile than similar soils on gentle slopes. Fragility is a state of soil being and may be drastically changed over time. Some soils are naturally fragile; some have become fragile from misuse and abuse; others have disappeared leaving bare bedrock exposed.

Rangelands—at Close Range

Harland E. Dietz, national range conservationist,
Soil Conservation Service, Fort Worth, TX, and
Harlan C. DeGarmo, range conservationist,
National Technical Center, Soil Conservation Service, Lincoln, NE

Rangelands are the principle source of forage for domestic livestock—producing meat, milk, wool, mohair, and many other animal products. They provide habitat for a wide array of wildlife species including grazing for big game and food and cover for birds and small animals. As watersheds, rangelands provide a quality source of water to a growing urban population. Recreation, firewood, and charcoal are becoming range cash crops in some areas where the resources support such enterprises. Rangelands are diverse and difficult to define and poorly understood both in terms of their value as a national resource and the importance of managing them correctly.

A home for natural vegetation, range represents the climax plant community of predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing use. Among the many forms of rangelands are natural grasslands, savannahs, wetlands, some deserts, tundra, and certain forb and shrub communities. It is uncultivated land and with few exceptions it is not fertilized, overseeded, irrigated, or mechanically harvested.

Location and Types of Rangeland

Slightly more than 700 million acres of these natural range ecosystems abound in the United States. The major portion occurs in the States lying west of the Mississippi River. Only about 6 million acres are eastward along the southern Gulf Coast and in Florida.

Categories separate rangelands into broad regions, types, or areas.

1. The *tall-grass* area originally occurred as far east as Indiana and Illinois with the western edge approximating the 100th meridian.

2. West of the tall-grass area is the *mixed prairie area,* dominated by lower growing species.

The *short-grass prairie area* is characterized by low-growing species.

3. The *southeastern rangelands* occur along the Gulf coast from Texas to Florida.

4. The *southwestern rangelands* extend from west Texas into New Mexico, Arizona, and Nevada.

Good grazing management has allowed dominant bluestem grasses to perpetuate on the range in a Kansas mixed prairie area. (SCS)

5. The *intermountain basin rangeland area* is not a continuous unit like the prairie regions. These basins extend throughout the intermountain region between the Rocky Mountains on the east, the Sierra Nevada, and Cascade ranges on the west.

6. The *west coast annual rangelands* are largely restricted to the Mediterranean climatic region of California.

7. The *northwest bunchgrass rangelands* of Idaho, Oregon, and Washington are characterized by the extent and dominance of blue bunch wheatgrass.

Diverse Native Plants

Within each of these major physiographic areas is contained a wide diversity of native plant communities. For example, within the tall-grass prairie there are large acreages of shallow soils and claypan soils that inherently support climax plant communities representative of the short-grass prairies lying several hundred miles to the west. Similarly, within the prevailing short-grass regions are areas of sandy soils, bottomlands, and soils having high water tables where conditions are favorable for growing taller grasses.

Range Sites

Essentially, rangelands are a mosaic of natural ecosystems. A single ranch or even a fenced pasture will possess several dissimilar plant communities. The inherent differences of these communities should be recognized and understood when developing plans and schemes for improved management of the resource. These micro-units, or ecological subdivisions of the rangeland landscape, are referred to as range sites. They become the basic interpretive units for study, inventory, planning, and management. Understanding the parts of the rangeland complex is essential in management of the whole.

A range site is defined as a distinctive kind of rangeland in its ability to produce a characteristic natural plant community. A range site is the product of all the environmental factors responsible for its development including soils, topography, climate, and fire. Each site supports a plant community that differs from that of other range sites in the kind or proportion of species or in total production. Range site information can be interpreted as to suitability of a site for a single use such as grazing or for multiple uses including wildlife habitat, watersheds, recreation, and natural beauty.

The native plant community occupying a range site in the absence of abnormal disturbance and physical site deterioration is referred to as the climax community for that site. It is the plant community that is best adapted to the unique combinations of prevailing environmental factors. Although there is some variability, the assembly of species of the climax community for a range site is relatively stable and is approximately the same from place to place within a county or parish and will occur with reasonable predictability. Essentially, the climax represents the potential plant community for a site and is the culmination of thousands of years of evolution.

Range Site Records

The policy of the Soil Conservation Service is to conduct detailed soil surveys in each county to collect essential soil information. In each survey area where rangeland is a recognized resource component, each plant community has been evaluated and meaningful distinctions have been made in identifying range sites. The ecological data for each site has been recorded in an orderly format referred to as Technical Range Site Descriptions. As many as 40 range sites have been recognized within a single county, and the assembled data is on file in each Soil Conservation Service field office. These descriptions become a repository of interpreted data of plant communities and serve as a basis for planning rational use and management on rangelands.

For convenience range site names are based on permanent physical

Livestock graze on a prairie in a Texas tall grass area. (SCS)

features, generally relating to kinds of soil or topography. Examples include such names as Clay Upland, Pumice Hills, Sandy Plains, and Wet Meadows.

Technical Range Site Descriptions contain pertinent data on species, composition, production, soils, topography, and climate. Site interpretations provide information on major uses including grazing, wildlife habitat, and watershed quality. They also provide a sound basis for the selection of species to be reestablished through revegetation programs.

Causes of Decline

Where climax plant communities are subjected to continuous heavy grazing, or where an environmental component important in the development of the climax vegetation is removed or altered, such as fire or the total removal of grazing, then the composition of the vegetation is subject to change. Livestock graze selectively and, depending on the kind of grazing animal and season of use, preferred plants are weakened and replaced by less preferred plants. If overgrazing continues for extended periods the vegetation may undergo dramatic changes.

On some range sites, woody plants have invaded or thickened with the cessation of fires. Plant composition may also be affected on many sites if grazing is omitted for years, resulting in excessive accumulations of plant residues. Changes in vegetation from these causes generally are gradual and follow a somewhat orderly sequence of departure or degradation from the climax plant community. Any departure from climax denotes a change in the health or condition of the vegetation on a range site.

Determining Range Condition

Quantitatively comparing vegetation

presently growing on a range site to the climax plant community for that site is referred to as determining range condition. Four classes of range condition are recognized for use in expressing the ecological relationship of the present plant community to that of the climax community for a range site. They are excellent, good, fair, and poor. Excellent condition means that over 75 percent of the present plant community is climax for the site. Good condition means 51 to 75 percent is climax, fair is 26 to 50 percent, and poor condition class indicates that 25 percent or less of the present vegetation is climax for the site.

Generally, trends in degradation in the plant community, whether caused by overgrazing, prolonged drouth, wildfires, insects, or physical disturbances, can be reversed when the causes are corrected. Secondary plant succession operates to reestablish the climax plant community if remnants of the original plants are still available and if the site has not been severely damaged by erosion.

Determining range condition is an essential component in rangeland inventories. It provides the basis for interpreting the effects of past management and for predicting the extent of change that can be expected from improved management and treatment. This applies whether concern is with a single pasture, a ranch, county, state, or even on a national basis.

Although determining range site and range condition does not automatically indicate the exact value of a plant community for forage production, wildlife habitat, watershed, or other specific uses, it does provide insight to the quality level of these values. A range site or a pasture or ranch having sites in predominantly good and excellent range condition is generally considered to be producing near its potential and attaining a high degree of efficiency in providing the other major amenities of rangelands including water yield, water quality, erosion control, and wildlife food and cover.

A Specialized Field

An understanding of rangelands has evolved over the last 40 years, to where today it is recognized as a specialized field of study. Ranchers, researchers, and range conservationists have drawn knowledge from the plant and animal ecologist, animal scientist, chemist, soil scientist, and climatologist. This knowledge has been brought together into the field of knowledge known as range science.

The current level of knowledge provides for the proper management of most range sites to achieve a level of sustained productivity and supplemental benefits. As the study of the relationships between plants and other organisms advances, the possibilities for refinements in management of rangelands will be enhanced.

The goal of range management should be to use the range resource, the vegetation, for the benefit of people and do so in a manner that the resource base is not degraded but perpetuated.

Tooling Up for a New Vision of Earth

Walter R. Butcher, professor of agricultural economics, and
Bruce E. Frazier, associate professor of soils,
Washington State University, Pullman

Soil scientists know the physical, chemical, and biological soil properties and the interactions between climate and soils, water and soils, and plants and soils. Hydrologists understand how water moves across the surface of soil and through the soil into underground aquifers. Agronomists and other plant scientists can explain how agricultural crops, trees, and natural environments respond to land treatment. Geographers and topographers know how different lands and soils are spread across the landscape.

This scientific knowledge complements the individual experience of those whose work is the land and provides them with tools to further extend their understanding.

Classification and Mapping

The American system of classifying soils according to their properties was developed during the 1930's and first published in the 1938 *Yearbook of Agriculture*. A successor to the 1930's system, *Soil Taxonomy* is presently used to classify soils according to properties such as color, texture, structure, arrangement of horizons in the soil profile, and accumulation of clay, silica, carbonates, and humus. The most detailed category is the soils series, which defines the range of properties for a particular class of soils. Different soils series are grouped into a hierarchical system that is designed so that information about how a particular soil is classified will help in understanding that soil's reaction and response to changes.

The Soil Conservation Service, U.S. Department of Agriculture, has developed an interpretive classification system that groups soils according to potentials and limitations for sustained crop production. Capability Class I soils are deep, well-drained, good textured soils without erosion problems and few if any limitations to crop production. Class II, III and IV soils are increasingly unsuited for crop production, because of shallowness, steepness, dryness, risk of soil erosion, or wetness during the growing season. Soils in Classes V through VIII are not suited for cultivation, and Class VIII soils are also severely limited for range and pasture uses.

Soil surveys in the United States have classified most of the areas predominantly in farmland as well as substantial areas of forests and rangeland. Once the soils are surveyed, the information is used to prepare a detailed soils map to assist in farm land-use planning and management. Soil surveys also show the associations of soils related to differences in topography or major geographical features.

Sound decisions about land come from a thorough knowledge of its topography, climate, surface and subsurface drainage, and substructure.

Crop Productivity

Soil type, capability classification, and other information about a particular piece of land can be used to predict its capacity to yield crops. Most soil surveys do provide information about prospective yields, but not on the impact of erosion on yields.

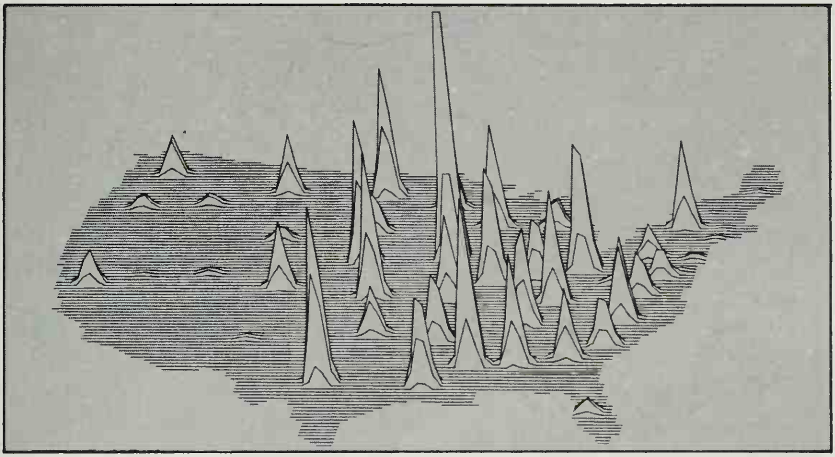
Predicting Erosion Effects. In 1981, a USDA-appointed Research Planning Committee recommended a combination of field experience and mathematical modeling to help predict productivity impacts of erosion. Scientists from a broad range of disciplines, sponsored by USDA's Agricultural Research Service, designed the Erosion-Productivity Impact Calculator (EPIC) to predict how productivity will change over time under a range of conditions.

The EPIC model includes factors like weather, hydrology, tillage, erosion, nutrients, soil temperature, plant growth, and economics. The computer submodel for each division contains mathematical representations of key physical and biological processes. For example, the hydrology submodel simulates surface runoff, evapotranspiration, percolation, and subsurface flows as a function of rainfall, topography, soil type, ground cover, stored moisture in the soil profile, and so forth. The variables and functions in the submodels are interlinked through time. Each variable is updated daily. For instance, rainfall during day 1 affects soil moisture in day 2, which then affects percolation, and so on.

The first six divisions of the EPIC model deal with physical and chemical soil characteristics. The way precipitation falls on land with surface roughness, crop residues, moisture concentrations and other specific conditions determines the amount of runoff and the amount of erosion that will take place. The universal soil loss equation (USLE) is useful in estimating how much soil will be carried with the runoff water under different field conditions. The EPIC model predicts wind erosion, again based on characteristics of site and time.

Determining Growing Conditions. Physical and chemical processes represented in EPIC also help to determine the growing conditions for a crop. A general plant growth model simulates the growth of 11 different crops. The growth model simulates solar energy input to the plant, energy conversion to roots, aboveground biomass, and crop. The growth model also simulates water and nutrient uptake and is constrained by water availability, nutrients, air temperature, and solar radiation during the growing season.

The economic submodel predicts the cost of tillage and other operations and determines the revenue based on



The CARD Model is a series of computer programs developed at Iowa State University. It projects the interrelationships of agricultural resource and factor use and production. The model can generate maps such as this one showing each State's projected level of soil loss per acre for 1990. (Center for Agricultural and Rural Development, Iowa State University)

the crop output predicted by the growth model.

While the EPIC model predicts how yields will vary among sites, its greatest usefulness is in suggesting how yields from a field will change over time. Erosion reduces productivity because surface soil containing organic matter and nutrients is carried away. Soil fertility and moisture-holding capability declines gradually. So do crop yields from year to year, but in time the deline becomes pronounced.

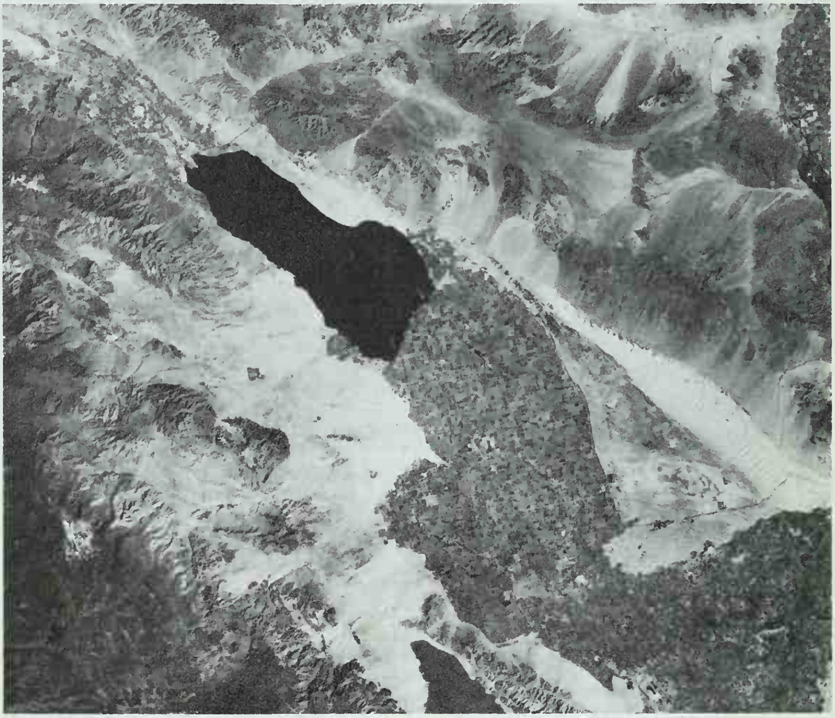
The EPIC model was designed for solution on relatively small personal computers. It is convenient to use and relatively inexpensive. Large weather and soils data files were assembled so that the model can be applied throughout the United States.

Information on the impact of erosion on productivity is useful in calculating longrun costs of ignoring erosion compared to the costs and profitability of practicing conservation. This knowledge is useful in preparing a farm conservation plan.

EPIC model results are useful, too, in assessing consequences nationwide among alternative conservation policies. In fact, the first major use of the EPIC model was to simulate the change in soil conditions and yields under conventional versus alternative conservation tillage methods, under alternative crop rotations, and using different conservation measures.

National Resources Inventory (NRI)

The National Resources Inventory (NRI) was first conducted in 1977 and again in 1982. It provides estimates of



A photograph made from a satellite 520 miles above the earth shows the Salton Sea and surrounding area in southern California. The checkered pattern is irrigated cropland; in the original color infrared transparency, crop condition and yield potential can be determined. The light area near the center of the irrigated cropland is urban land. The large area covered by satellite images (in this case, 110 square miles) allows interpreters to see regional differences in soil, vegetation, and geology. (Reproduced by permission of EOSAT)

land in different quality classes as well as of soil erosion, land's conservation needs, its potential as cropland, what its current use is, windbreak location, its cover conditions, and where the wetlands are. NRI is a status report on our land resources and their use and, because we have two inventories, a means of estimating changes in land use and in land conditions.

NRI data serve as a primary data base for the Soil and Water Resources Conservation Act (RCA) appraisal of the Nation's soil and water resources and conservation program needs. The second RCA appraisal is scheduled to be published in 1987.

Interregional Economic Model (CARD)

The Center for Agricultural and Resource Development (CARD) at Iowa State University has developed an interregional modeling system for projection and economic analysis of agricultural production and resource use. The CARD model combines EPIC predictions of erosion impacts on productivity with experts' projections of the trends in crop yields and livestock feeding efficiency. These, in turn, produce projections of potential crop and livestock output under a wide range of alternative uses of the Nation's land resources.

Remote Sensing

Remote sensing has contributed much and promises to contribute more to our understanding of the landscape. It provides us with a means to monitor our land-use practices and an early warning system for global ecology. Through its use science can measure our environment while not being directly in contact with it.

Aerial Photography. The most familiar applications of remote sensing include the use of aerial photography. Agriculturalists use it to watch the growth and development of crops, and foresters check the health of trees on color infrared photographs. Pictures are taken weekly by consultants who advise farmers and orchardists with large acreages under irrigation. When analyzed thoroughly, color infrared film may reveal characteristics about a growing crop that can be used to enhance crop yield and value. Nitrogen deficiencies, disease infestations, and water distribution problems may be corrected before debilitating damage has occurred.

Satellite Imagery. In recent years, satellite imagery has added much to our understanding of the Earth on a national and global scale. Satellites carry sensors that record reflected and emitted radiation in much longer wavelengths than could be used previously. They have expanded our ability to study moisture relationships in plants and soils, the mineral composition of rocks and soils, and the temperature and surface conditions of the oceans.

From satellite data, researchers determine biomass on range areas around the globe, how much area is in major crops and the condition of those crops, and with appropriate ancillary data, predict their forthcoming yield.

Soil scientists are studying the effects of erosion on agricultural soils using satellite data. The amount of organic matter in surface soils can be monitored.

At the national level, the Economic Research Service, USDA, is using photographic data from EARTHSAT and other sources to determine land-use changes during the 1970-80 decade in 138 fast-growth countries and how much existing or potentially productive cropland is being lost from direct and indirect effects of urbanization.

Land as a Global Resource

Gerald W. Thomas, president emeritus,
New Mexico State University, Las Cruces

American land is a global resource. It supplies much of the world with food, fiber, and forest products. It is a vital asset to the Earth environment. It is the base upon which new production and conservation technologies have been devised and improved upon for application around the globe.

Alleviation of World Hunger

Total volume of food produced in each of the last 5 years has exceeded the net gain in world population. Per capita food availability is improving. Even so, millions will suffer from malnutrition due to unequal distribution and poverty.

Despite the world food surplus, many people in the world still lack food security. This year a worldwide net gain in population of 83 million is expected—most of these in the developing countries.

In the short term, world hunger can only be alleviated by emergency food aid. During 1984-1986, overall U.S. aid to Africa for drought relief was $2.2 billion. It amounted to 6 million metric tons of food from the United States or about 30 pounds of food from each of our 240 million American citizens. Total food aid shipments to the world's hungry in 1985 and 1986 from all donor countries was 9.5 million tons. Fortunately, the United States and other high income countries always respond to famine whenever it occurs.

Longer term or chronic problems in poor countries have been approached by the United States through economic assistance programs of the U.S. Agency for International Development and through cooperation with the World Bank and United Nations. These programs try to increase local food production to reduce malnutrition, with emphasis on education, research, and technical assistance. By helping these countries increase their per capita income, they tend to purchase more products from the United States. Forty percent of our agricultural exports now go to developing countries. Total U.S. agricultural exports reached a high of $40 billion in 1980. At that time, nearly 1 out of every 2.5 of our acres was producing food for export. Agricultural exports dropped from a high in 1980 to a level of $26.3 billion in 1986. American land still produced food for many millions of people. Nevertheless,

U.S. soybeans arrive in Manilla and are loaded off ships onto barges. (Dana Downie, 0785X666-35A) the substantial loss of foreign markets since 1980 has caused turmoil for American agriculture.

How much land is required to sustain an individual to a satisfactory standard of living? In 1946, the Soil Conservation Service estimated that the average American needed about 1.2 hectares (2½ acres) of cultivated land to supply annual food needs. American farmers were told that, while the United States had a land surplus, there was not enough good land in the world to provide a satisfactory level of living for the total population. Therefore, it was imperative to carefully conserve every acre in the United States as an obligation to a predominantly hungry world and as a safeguard for future generations. That was 1946—following reports of 3 million deaths in India and another 3-4 million deaths in China from starvation.

This approach to promoting soil conservation helped. But was the reasoning sound? What has happened to that so-called "2½-acre requirement" in the past 40 years? The major impact of new technologies in the agricultural sector came after World War II. Hybridization, a revolution in agricultural chemicals (particularly pesticides and fertilizers), irrigation, a major move toward mechanization, significant improvements in food processing and distribution, and many other new technologies swept through the food sector. No longer are 2½ acres of arable land per person required. This basic requirement has been reduced substantially and continues to vary with the level of productivity, the kinds of crops produced, the quality of the land, and our concepts of an adequate standard of living. However, none of the new technologies on the horizon will separate people from dependence on the land for food production. American land will continue to supply a part of the food needs of many people in foreign countries.

Forest Products

Worldwide ties to American land also can be demonstrated outside the food sector. The United States is the world's second largest exporter of forest products, with about 15 percent of the world market share. At the present time, the United States ships about 20-30 million metric cubic meters of forest products to other countries. The primary markets for U.S. wood products are Japan, China, Canada, South Korea, and West Germany.

As the world's population increases, and as many developing countries continue to exploit their valuable forest resources, concern about the limited world supplies of forest products will increase. Also, a better understanding of forest ecosystems and the importance of maintaining biological diversity, will lead to more careful use—and perhaps reduced harvest of forest products—in environmentally sensitive areas. The United States has instituted reforestation programs, sustained yield concepts, and multiple-use programs that should secure the position of

Many modern U.S. soil and water conservation practices are found throughout the world. This low irrigation sprinkler provides broad area coverage and can be moved easily. (Tim McCabe, SCS, CA-7515-24A)

American forest land as a true global resource.

Fiber

American land is an important source of production for the world's natural fibers—particularly cotton, wool, and mohair. These natural fiber industries have undergone three major changes in recent years: (1) The source of production shifted as developing countries search for a cash crop to supply much needed foreign currency; (2) The international trade of natural fibers shifted toward Asian nations as they develop textile industries based on low labor costs; and (3) Synthetics continue to encroach on the natural fiber market.

The United States remains the major exporter of cotton with about 30 percent of the trade. Other leading exporters are the U.S.S.R., China, India, Pakistan, and Sudan. Japan, South Korea, Taiwan, and others are increasing their cotton imports. Western Europe accounts for about 25 percent of the import market.

Sheep numbers continue to decline in the United States as they have for decades although the trend is slowing. More than 10 million sheep and about 2.5 million goats in the United States supply 5 percent of the world's consumption. The U.S.S.R., Australia, and New Zealand remain the leading producers of wool.

Science and Technology

The vast, variable, and productive American land challenges scientists as well as farmers, ranchers, and agribusiness people to produce in abundance. So, American land justifiably can be considered a global resource for new developments in science and technology.

The chemical revolution, hybridization, genetic engineering, and other

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FURNISHED BY THE PEOPLE
OF THE
UNITED STATES OF AMERICA

Much needed food grown by U.S. farmers arrives in Honduras, one of many countries with insufficient food to feed its people. (Susan Scarfman, AID)

achievements were essential to building the United States food dynamo. But the American land itself also contributed the proper environment—a land base. Government policies encouraged production and a land-grant university/U.S. Department of Agriculture cooperative system tied together the three important elements of success: Education aimed at the "common man," research focused on current problems, and Extension to carry the information to the farmers.

The Title XII amendment to the U.S. Foreign Assistance Act of 1975 was designed by Congress to encourage the developing countries to use the U.S. land-grant model to increase their own food production. The "institution building" approach to third-world country development is now a major objective of the U.S. Agency for International Development.

The land-grant system led to creation of new agricultural professions—animal husbandry (from veterinary science), agricultural economics (from business and economics), range ecology (from plant and animal science), and vocational agriculture. These fields are now well established and represented by worldwide professional societies. Concepts of agricultural extension and technology transfer now are used in the institutions of developing countries. Youth programs of 4-H and Future Farmers of America can now be found in third world countries.

Conservation Ethic

During the frontier settlement in America, and for many years thereafter, the emphasis of research, extension, and government programs was on increasing production to meet the needs of a hungry world. At some point in our history, however, Americans began to realize that our land resources were not unlimited and that our policies were leading to indiscriminate sodbusting of marginal lands, overgrazing by livestock, and general neglect of the valuable resource base.

A shift in American policies from exploitation to conservation was powered by the Dust Bowl disaster of the 1930's. Great "evangelists" for conservation emerged such as Hugh H. Bennett, W.C. Lowdermilk and Gifford Pinchot. These leaders helped establish the Soil Conservation Service, the present organization of the Forest Service, and approaches to both public and private land management that incorporated the conservation ethic.

Environmental Movement

Early concerns about conservation aimed at sustaining the productivity of the environment. Concerns about its capacity to absorb pollutants did not come until the environmental movement of the 1960's and 1970's. Since then, water and air pollution, major changes in biological populations, and perturbations in ecosystems have been and continue to be explored. Protection of endangered species, reduction of chemical pollution, and close study of possible climatic change are now areas of concern and research.

Wilderness Areas

The concept of wilderness areas probably originated in the United States. Dr. Aldo Leopold, an employee of the U.S. Forest Service, was instrumental in designating the first wilderness as a part of the Gila National Forest in New Mexico over 50 years ago.

The next phase of the conservation and environmental movement will be focused on the need to better understand natural and human-influenced ecosystems—systems that operate in the biosphere and geosphere. Far too little is known about the hydrologic cycle, energy flow, air pollution, and the potential for human-caused climatic change. The development programs and resource management policies within one country often impact on other countries.

America, because of its valuable land base, can and will continue to contribute to both production technology, to soil and water conservation practices, and to a better understanding of the complex environment of which human beings are a part.

Managing Land Use

Part IV

Resolving Issues With People, Not for Them

Sherman Swanson, assistant professor,
University of Nevada-Reno, and
John L. Artz, national program leader, Rangeland Management,
Extension Service

Decisions about the ownership, use, and management of American land always have evolved out of conflict. Treaties, legislation, and court decisions have been our traditional means for resolving land disputes.

Today, while people must deal with land and resource issues more and more, legislation often seems too vague and courts too slow. This is increasingly true in the Western States where Federal lands are a major resource, multiple use is an economic and political necessity, and where many issues require local solutions.

Resource managers, landowners, and public officials, are exploring new ways to work with people to resolve these kinds of resource problems. The process they developed is called Coordinated Resource Management (CRM). CRM advocates feel it applies wherever people want to work together to resolve resource conflicts.

What Is CRM?

Coordinated Resource Management helps owners, resource managers, and resource users to develop and carry out a plan for managing a specific area. CRM plans can stand alone or be part of a larger, more formal local, State, or Federal plan. The CRM process is sometimes initiated to free up a stalled planning process.

Open communication is the key. All principal participants, including land owners, resource managers and users, and specialists, public officials, and business representatives, consider the available resources, address problems and opportunities, and evaluate management strategies. Their decisions, plans, and recommendations are determined by consensus rather than by majority vote. Owners and managers do not lose authority or legal responsibility. Rather, they make decisions in an environment that generates knowledge, cooperation, and support.

Although CRM is a process, not a program, it has been sanctioned by a Federal memorandum of understanding for at least 15 years. The current agreement is between the Soil Conservation Service, (SCS), the Forest Service (FS), the Bureau of Land Management (BLM), and the Extension Service (ES). The memorandum encourages

Ranchers and representatives from government agencies and conservation groups discuss a Coordinated Resource Management plan. At the outset, all participants visit the planning area together and discuss conditions "on the ground" where perceptions can be compared to reality. (BLM)

participation by additional organizations within the States.

At least 11 States have CRM memorandums of understanding. These involve States and Federal agencies as well as other organizations. Most agreements provide for a State Executive Committee of agency heads, an interagency task group to provide ongoing leadership and support, and a process for assisting locally formed CRM groups as needed.

Early Work on Rangeland

About 1950, rancher "Speed" Agee and Chet Cleary of SCS were successful in establishing the Northeast Elko Conservation District in Nevada as a model or "pilot" district for developing and demonstrating cooperative, coordinated resource planning and management. The principal cooperators with the S.C. District were BLM, FS, SCS, and the Nevada Fish and Game Department.

At about the same time, E. William (Bill) Anderson, SCS Range Conservationist, began pioneering this approach in Oregon. Now retired, he continues to teach, write, and advise on CRM. Likewise, organizations such as the National Association of Conservation Districts and the Society for Range Management encourage private and governmental support for the concept and the process.

Early coordinated management work primarily involved livestock grazing on interdependent and often intermingled public and private rangeland. The CRM team usually were range conservationists from two or more agencies and the ranchers with grazing privileges on public lands in question. The plan they developed was for both the public and private land and included range improvement projects and grazing schedules designed to meet the needs of the range ecosystems and the livestock operation.

Expanded CRM Applications

Of course, interests beyond those mentioned so far may have good reason to participate in coordinated resource management. Foresters, recreationists, fish and wildlife managers, and local officials all make decisions about the same land. In short, every CRM team must include all the interested parties to be effective.

Some Examples

Residents of Glenbrook Bay, Lake Tahoe, Nevada used CRM to plan present and future uses of the bay including the protection of historic artifacts.

The Draper Canning Company, Sussex Conservation District, SCS, Cooperative Extension Service, the State Department of Natural Resources and Environmental Control, and the Forestry Section of the State Department of Agriculture are completing work on a CRM plan in Delaware. It will reduce erosion, protect ground water, eliminate runoff of contaminated water from seven feedlots, and provide for disposing of manure to fertilize crops.

CRM was used extensively for enhancing elk habitat with managed cattle grazing on the Bridge Creek Wildlife Management Area in eastern Oregon. In Benton County, Oregon, CRM was used to reduce damage by geese to private lands near wildlife refuges.

CRM was used in Oregon in managing a coastal forest watershed where the issues included anadromous fish, elk, and deer winter range and recreation. Participants included two lumber companies, two State Agencies, the Northwest Steelheaders Council, three Federal agencies, five private landowners, the Lincoln Soil and Water Conservation District, and Lincoln County, Oregon.

California currently reports 81 CRM plans encompassing 6,644,000 acres. Management objectives include fuel hazard reduction, fisheries and wildlife habitat improvement, drainage outflow reduction, agricultural crop production, watershed enhancement, range improvement, timber improvement, and recreation.

One of the largest CRM plans was developed by users and managers of the Sheldon National Wildlife Refuge in Nevada and Oregon. This plan for 576,000 public and private acres was signed by 11 livestock permittees, four Federal land managers, wildlife biologists from two States, university range extension specialists from two States, and representatives of the Nevada Wildlife Federation, Wild Horse

Organized Assistance, and the Sierra Club. Other plans have dealt with areas as small as a 2,400-acre, State-owned wildlife management area in Oregon.

Common CRM Elements

CRM is a social process as well as a mechanism for decisionmaking. No single "right way" to practice CRM exists, but there are elements that can be identified.

- Voluntary participation of all affected interests
- Joint onsite problem identification.
- Open communication among all participants
- Availability of technical expertise
- Strong and effective local leadership
- Agreement by team consensus.
- Commitment to cooperative monitoring and annual review

CRM is built on the idea that when people affected by resource management decisions are responsibly involved in making those decisions, there will be more effective resource management and fewer problems to be settled by courts and legislatures.

Finding the Living Past in a Silent Landscape

Evan DeBloois,
historic preservation officer,
Forest Service

The silence of the canyon was broken by the sound of the helicopter as it cleared the rim of the mesa. The machine looked insignificant in comparison to the 2,000-foot-high, red sandstone walls, as it began its familiar routine. Slowly it followed the canyon wall just below the rim until it came to another drainage cut. Then it flew up the opposite side to where it had begun. Dropping midway down the wall, the craft repeated its slow circle, then flew one more circuit near the canyon floor before moving to the next canyon.

For 2 weeks the deep canyons were systematically searched. An archeologist was in the helicopter with the pilot. Wearing a USDA Forest Service uniform, he was locating, photographing, and mapping the ruins of prehistoric Indian inhabitants of these remote canyons.

As each ruin was sighted, the craft circled while a map was marked with the location and a photograph was taken to be studied later in the office. Mile after mile of spectacular canyons remains to be examined, as do hundreds of ancient dwellings and storage structures.

Seeking the Past

The helicopter survey of Elk Ridge Mesa on the Manti-LaSal National Forest exemplifies the Forest Service's Cultural Resource Management Program. Hundreds of the agency's trained archeologists, historians, and technicians criss-cross public lands to identify physical remains of an old and often ancient past. Abandoned farmsteads and cellar holes in the hills of New England, brick house piers and ruined mills in the woods of the South, mines, mills, and ghost towns of the West, prehistoric pueblos of the Southwest, burial mounds in the Ohio and Mississippi Valleys—all bear silent witness to events and the lives of people long gone.

Since When?

The Forest Service has been managing these fragile and irreplaceable resources since the first Federal law was passed in 1906 that reflected the public interest in protecting important archeological remains from needless destruction and damage. Both the agency and the science of archeology were in their infancy in the early part of the 20th century, and it was not

A Forest Service archeological crew records the location of burned roof timbers on the floor of a shallow pithouse in Utah's Fishlake National Forest. Charcoal from the beams indicates the circular house was occupied 1,300 years ago. (FS)

until 1970 that professionally trained archeologists were employed to develop programs. This professional staff has since grown to over 130 individuals.

These specialists carry out a range of activities. They begin by identifying historic and prehistoric resources of the land. This is done in parts. First is the examination of existing records and documents to see what information exists. Then follows the search for clues that will help in locating these resources. Histories, old tax records, journals, probate records, General Land Office maps, and census records are sources of information on where historic remains may be found.

Secondly, the field survey walk is conducted over the land to note the existence of artifacts and features that remain preserved from the past. Sometimes sophisticated electronic equipment is used to find artifacts hidden in the earth or covered by leaves and vegetation. Aerial photographs and satellite sensing data flag places where people have lived.

The 900-year-old storage rooms hidden out of the weather beneath a sandstone ledge once held the maize crop of the inhabitants of what is now the Manti-LaSal National Forest in Utah. (FS)

Assessing Values

Once cultural properties are discovered, their importance is evaluated. Some hold vast stores of scientific knowledge about past peoples and cultures while others disturbed by erosion, development, or illegal digging offer little. This evaluation helps determine what degree of management attention is appropriate.

Organizing the Finds

Properties may be important for their potential archeological knowledge, or they may show interpretive potential. They may represent people or events that have national, regional, or local significance. They might demonstrate how natural processes cause deterioration. This evaluation is called allocation.

Sites with high interpretive or recreational potential are identified for future development along those lines. Sites of national significance are listed in the National Register of Historic Places and protected from development and vandalism. Sites of scientific interest are excavated or otherwise researched, especially if they are threatened by development. Each class of property requires specific approaches in managing them.

Why?

The Forest Service's Cultural Resource Management Program is intended to protect, preserve, and interpret the Nation's cultural heritage. Development activities must not inadvertently damage or destroy important cultural resources. More than 7,000 development projects are carried out and over 11,000 cultural properties are identified annually.

Public Interest

Where possible, artifacts are placed in visitor centers and public museums. Historic buildings and structures often are preserved and reused to enhance public appreciation of their origins.

This program is relatively new, yet its accomplishments have been extraordinary. Public participation in the management of this growing cultural heritage is expected to grow. Already volunteers are finding, examining, and recovering knowledge coming out of these prehistoric and historic properties.

The shadows grow deeper in the canyon and the light begins to fade as the helicopter climbs laboriously to the top of the surrounding mesa. The day has been successful and many new sites marked. Soon the crew will be back in camp checking the day's results and planning tomorrow's search. In the fading sunset they reflect on the newly discovered prehistoric ruins that can now be actively managed and preserved for people and science.

The Evolution of Land Ownership

Gene Wunderlich,
agricultural economist, Economic Research Service

In July of 1787, Manasseh Cutler, lawyer, physician, preacher, and real estate dealer, persuaded the Congress to quickly pass the Northwest Ordinance, and coincidentally sell 1.5 million acres of the new territory to his Ohio Company. The Ordinance became the "settlement constitution" for territory west of the original colonial states. The Ohio Company land deal became a milestone in real property speculation.

Today land is still an economic good which may serve as a financial asset, a factor of production, or a consumption good. Land also serves psychological, social, and political purposes. All these purposes are reflected in landownership, its past and present status in the United States, and its likely direction in the future.

Landownership

The first, and most general classification of landowners is public and private. The proportions of land in public and private ownership vary widely among nations ranging from total public ownership to a substantial proportion in private ownership, as in the United States.

In the United States, about 60 percent of the land area is in private, that is, nongovernmental, ownership. Virtually all of the intensively used, highly priced, land is privately held.

Landownership is widespread in the United States largely because of home ownership. About three-fourths of the 55-million owner-occupied and 30-million-renter units are detached or semidetached homes. These homes plus condominiums, cooperatives, and other communally owned units occupy land for residential purposes. While the area occupied by homes is insignificant nationally, the value of residential real estate is a substantial 60 percent of all real property.

However, nearly two-thirds of private land is agricultural, and most agricultural land, with the exception of grazing land in the West, is privately held. Only 3 percent of cropland is owned by government of any kind. In area, then, the predominant private landowners are farmland owners. About 60 percent of these operate at least some of the land they own. Farm operators own about 65 percent, and nonoperator landlords about 35 percent, of the land in farms.

Traditionally, ownership is the preferred form of land tenure. The preference reflects a belief that owned

About 65 percent of farmland is owned by farmers, about 35 percent by nonfarmers. This farmer harvests wheat near Culpeper, Virginia. (Tim McCabe, SCS, VA-5,274)

land is more efficiently used, or more responsibly cared for. To some, ownership represents achievement, security, or both. If land ownership is regarded as virtuous, tenancy is perceived as a symptom of faulty agricultural structure.

Land Leasing

Recently, in the face of stresses in U.S. agriculture, the role of land leasing is being reexamined. Declines in land values, such as those witnessed after 1981, can create insecurities in ownership, especially if accompanied by debt. The financial requirements of modern agriculture, the shrinking number of farm units, and risks of production and prices suggests a need to distribute both burdens and risks somewhat more widely than among farm operators only. Leasing meets many needs of modern farming.

Leasing has been part of American agriculture for a long time. Since 1900, the percentage of land in farms rented from others by the farm operator has varied between 35 and 45. Currently more than 40 percent of land in farms is leased. Most of the land is rented by farmers who themselves own some of the land they operate.

Leasing may be seen as a flexible but less secure form of land tenure than ownership. Agricultural leases are predominantly year-to-year, subject usually to a relatively short notice in advance of the production season. Typically, annual leases are automatically renewed and rental arrangements continue for many seasons. Tenants who operate only rented land average 10.7 years on their present farm according to the Census of Agriculture. Renters, who own at least some of the land they operate, average 17 years on their present farm.

Present trends suggest a future of increasing ownership of agricultural land by nonagricultural owners. During periods of stress, financial and other, institutions may become unwilling owners through foreclosure. But investors in agricultural land will continue to be farmers with nonfarmer individuals or partnerships in second place. Corporations now own between 12 and 15 percent of land in farms. Most of these corporations are small, family level units, with no inherent reason to enlarge their holdings beyond the sizes of their unincorporated neighbors. Furthermore, some States restrict ownership by nonfamily corporations.

Landownership as Economic Policy

Landownership at times has been an *object* and at times the *instrument* of policy. Economic, social, and political forces are presumed to be influenced by property, including property in land.

Efficiency Argument. The economic argument for private ownership of land is usually presented in terms of efficiency. The argument assumes rational self-interest and universally available information about technical relationships and prices. It also assumes that the owners know and respond to, but do not influence, either the technical relationships or prices.

The argument against absentee landlords is that they are uninformed about, or disinterested in, the longrun productivity of land and that they do not reinvest in the farms from which they draw income. In addition, tenants who are insecure in tenure are disinclined to use care in cultivating or to invest in conservation measures from which they may not get a full return.

Arguments in favor of absentee landlordism do exist. Absentee landlords with additional sources of income and tenants without mortgage debt may have larger capacity to contribute more to production and conservation practices than owner-operators. Tenure, as such, does not appear to confer economic superiority. While studies have tested the effects of tenure on resource use and investment, they did not reveal a consistent effect on efficiency or conservation keyed to particular kinds of tenure.

Distribution Issue. Landownership falls within the general concept of property and, in the words of the 19th century economist, Leon Walras, "...property defines the mutual relations established between man and man with respect to the appropriation of social wealth, and determines the conditions of the equitable distribution of social wealth within a community." The economics of landownership, therefore, is less a production and more a distribution issue.

How is the ownership of land in the United States distributed? As among all persons, very unevenly. Owners of farmland number about 3.5 million, or about 2 percent of the population age 18 and over. Because agriculture occupies such a large portion of the Nation's private land, and because such a small portion of the population holds agricultural land, landownership is concentrated.

Even among the holders of agricultural land, ownership is concentrated. Less than 3 percent of the owners of agricultural land own 40 percent of the agricultural land. Conversely, the half of the owners with smallest holdings own less than 10 percent of the land. Although land measured in terms of value shows less concentration than land expressed in acres, the distribution is grossly uneven.

Death, dissolution of business entities, and ordinary market transfers can cause accumulations of land to break up. Inheritance, marriage, market, and other acquisitions can create new or enlarged concentrations of land. The processes of change are relatively slow. Less than 5 percent of agricultural land transfers in a year, about one-third of the rate of urban residential land.

Long-Term Trends

These trends suggest a continuing stability in the number of agricultural landowners. The number of agricultural landowners is declining, but not as rapidly as the number of farms, and this is the primary force toward concentration in the holding of agricultural land. The proportion of nonfarm owners of farmland is increasing.

If farmers continue to be the dominant group among owners of farmland, ownership will continue to be concentrated in fewer owners. Ownership by nonfarmers could disperse ownership.

Contemplating the Urban Forests

Rowan A. Rowntree, project leader,
Northeastern Forest Experiment Station,
Forest Service, Syracuse, NY

A textbook on hydrology or meteorology written in the 1960's might identify urban areas largely as artificial surfaces devoid of fields and forests. U.S. Department of Agriculture Forest Service scientists, along with State, county and municipal managers, have found out otherwise. Our cities are, in fact, teeming with vegetation.

Seen from the air, a typical American city is about one-third trees, one-third grass, and only one-third artificial as in rooftops, roads, and parking lots. Even this overview understates the real volume of a city's vegetation.

To understand the value of and necessity for urban vegetation, scientists, planners, and managers have calculated the surface area of all the plants in a city to compare their findings to the exterior structural surface area of the city. The resulting ratio suggests the degree to which trees and other vegetation contribute to moving water, energy, and other matter through the urban system.

The researchers found that usually the leaf and stem surfaces in a city could cover the manufactured surfaces four times over. City planners now may see vegetation as the dominant component of the city's "infrastructure." And how does this new knowledge fit in with changing urban landscapes?

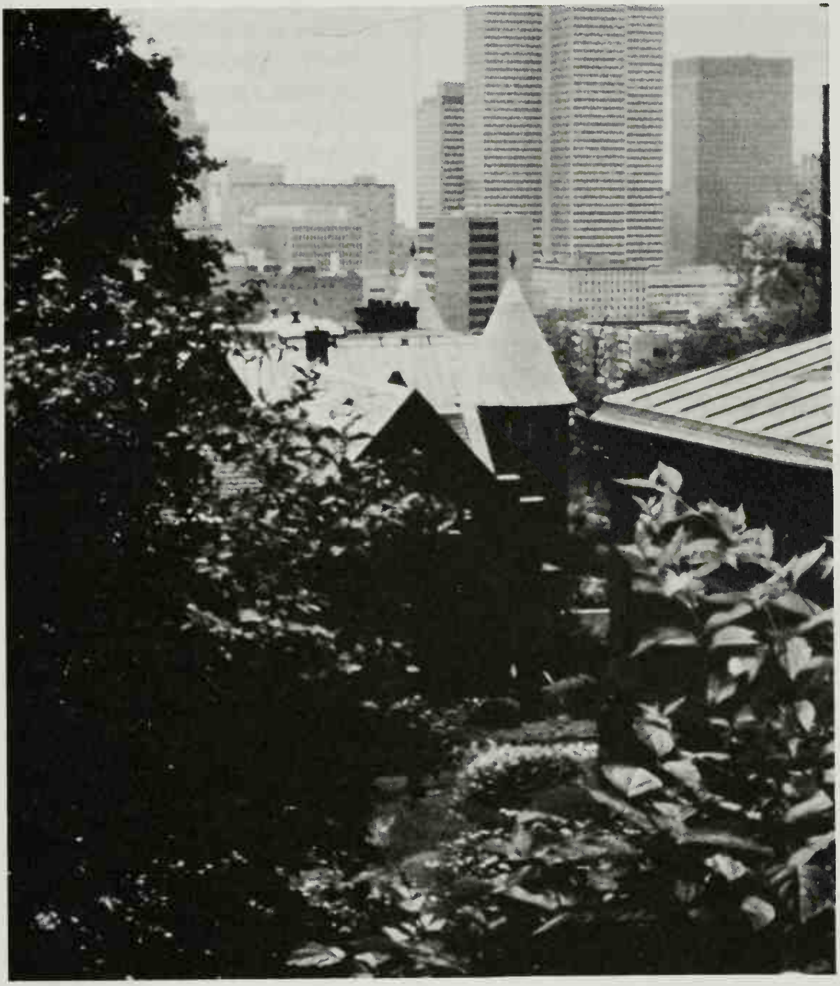
Abandoned Land

The oldest housing built in the late 1700's and 1800's was wearing out by the 1970's and being demolished in slum neighborhoods. Industry and institutions were moving from the city center to new sites on the urban periphery where they could build new and bigger facilities and access superhighways. Demolition and outmigration left much abandoned land in a doughnut-shaped pattern around the city center.

Plant and Tree Invasion

Plants and trees began to invade these vacant lands. Early forest succession was underway a stone's throw from downtown. This process attracted scientists, including those in USDA, whose job was to learn more about urban forests and soils. They were to probe a major and perhaps one of the last frontiers of scientific knowledge—the challenge to understand the influence of trees and plants in the old city and its new urban outcroppings.

Traditionally, the agricultural hin-



Understanding the ecology of the urban forest involves studying how tree and vegetation cover reduces air temperatures in the summer, allowing cooler, cleaner air to flow into the hot center city. Increased planting can reduce the "urban heat island," a source of discomfort and higher air-conditioning costs. (FS)

terland of a city was considered a botanical desert. But agriculture itself has become less diversified—a monoculture landscape surrounding the city that is, in marked contrast, a rich array of plants and animals.

Modern agriculture is leaving city lines and forests are invading the abandoned fields. Exotic trees planted in the suburban housing tracts compete with native trees, remnants of farm woodlots. Numbers and species of birds and mammals are increasing, too, amid new urban greenery. This change shows in States like New York, where forest area grew by 1.2 million acres between 1968 and 1980.

This new forest land is fragmented and would hardly turn a forester's head, but it is potentially a national hardwood resource.

The idea of an urban forest is an oxymoron—a contradiction of terms—to most people. A common misconception is that the urban forest is an artificial construction and will not behave as "natural" forests do. Thus, the argument goes, conventional forest science cannot be used in the city, making it impossible to practice scientific forestry there.

Professionals know, however, that except for the remaining old-growth forests of some western mountains, most forest land in Europe and North America has been violated by anthropogenesis, the intervention of human beings into biological processes. This ecological understanding of disturbed forest systems is useful in studying and managing complex urban forest ecosystems.

Understanding Tree Relationships

The urban forest is made up of different components, each behaving in its own way but all interacting.

Members of the urban forest family are: street trees, volunteer and planted exotic and native yard trees; islands of planted, residual or second-growth forest; islands of pioneer tree communities on abandoned land; and all "lower" vegetation associated with these forest components. The job, then, is to sort out these relationships and assign costs and benefits to each. Knowledge gained benefits urban dwellers and workers and adds to basic scientific thinking on plants, animals, and soils.

Tree Stress

Stress, for example—the urban environment is stressful for both people and trees, right or wrong? The street tree grows where its roots must find space around buried utility lines and sewers in soil severely compacted by vibrations of passing vehicles. Its crown is pruned severely when its natural form interferes with overhead wires. Its trunk is battered by cars and people, splashed with road salts and contaminated water off streets. Its air is filled with the fumes and particles of combustion. The surprise is not that urban trees succumb or decline early (if indeed, they do) but that they are as healthy as they are under this environmental stress. A recent study suggests that the growth rates of trees in difficult sites differ little from those in ideal sites.

Costs and Benefits

What are the costs and benefits of the urban forest? Who pays and who benefits?

Costs. Many of the costs are for maintenance—planting, pruning, fertilizing, watering, and removing trees.

Costs also occur when a limb falls on someone. How likely people in a society are to initiate lawsuits affects the costs too. Liability insurance and payments for damages are major factors considered by an urban forester in determining how many, how old, and how big trees should be. In this instance smaller is better.

Benefits. *Urban forests cut energy costs.* Trees and other vegetation reduce summer air temperatures and shade buildings; a city's energy bill would climb without vegetation, more effluent would flow from electric generating plants adding to air and water pollution. In test cities in America and Europe, forest scientists are studying the "urban heat island," that area of higher temperatures in the center of the city. Findings suggest that selectively planting trees around the central business district can reduce temperatures on a typical summer day by about 10 °F and create a flow of cooler air into the city center.

Urban Forests Reduce Air Pollution. Old people, poor people, and children often are exposed to auto pollution the most, while waiting for public transportation or playing near roads. Scientists are looking at what kinds of trees and lower vegetation are best for filtering the air.

Urban Forests Reduce Storm Runoff. In a storm dropping 1 inch of rain in 12 hours, urban greenspace will reduce runoff to the sewerage treatment plant by 20 percent. This means less runoff to treat and cleaner water at the plant outfall. It also means less flooding of homes and road intersections. Rainfall captured in the tree crowns flows down the trunk and infiltrates into the soil replenishing subsurface water supplies that are always low in the city.

Urban Vegetation Reduces Costs of Health Care. A study indicates that post-surgical patients recovered faster if they looked out their hospital window at a vegetated landscape. Hospital administrators, doctors, and hospital designers are interested in this finding.

Challenge for Science and Management

In Salt Lake City, urban foresters from the city and State cooperate with Forest Service scientists and remote sensing experts from the National Aeronautics and Space Administration and several universities to construct a dynamic model of the role of the expanding urban forest on future impacts of urbanization.

The training and experience requirements of urban foresters are among the most rigorous of all land managers. Soon, urban foresters will sit at powerful microcomputers plotting the optimum configuration of vegetation that will maximize benefits and minimize costs for their town, city, or metropolitan region.

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Arid Lands—Questionable Policies

Thadis W. Box, dean,
College of Natural Resources,
Utah State University, Logan

From the very beginning, this country had an abundance of land but a shortage of cash. Early land disposal policies were influenced by the need for money to operate the government. Many sales laws, enacted from 1785 to 1891, were designed for the more humid portion of our country, and had little relevance in the settlement of the arid West. During the latter part of the 19th century the need for generating revenue was superseded by the need to encourage settlement.

Land Disposal

1862 Homestead Act. The first major law giving free land to individuals in the United States provided that individuals could gain ownership of their land by living on it for 5 years and making specified improvements. Tracts of 160 acres could be obtained by private individuals, either by living on the land for 5 years or by outright purchase for $1.25 an acre after a 6-months' residence. This law worked reasonably well for the disposition of the highly productive lands of the Midwest. It was pitifully inadequate, however, for the settlement of arid or semiarid regions. A family simply could not support itself on 160 acres. Many attempts were made to settle the semiarid plains. Some of the more favorable areas were settled. Other attempts led to increased wind erosion and eventual abandonment by the settlers.

Powell's Report. Major John Wesley Powell, in a report on the arid lands of the United States[1] given to Secretary of the Interior Carl Schurz in 1878, called for major reform of land and water laws in the West to conform with the realities of nature.

He reviewed the land disposal laws before 1878 and concluded that they were inadequate.

> *If divisional surveys were extended over the pasturage lands, favorable sites at springs and along small streams would be rapidly taken under the homestead and preemption privileges for the nuclei of pasturage farms.*
>
> *Unentered lands contiguous to such pasturage farms could be controlled to a greater or less extent by those holding the water, and in this manner the pasturage of the country would be rendered practical. But the great body of the land would remain in the*

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[1] John Wesley Powell, *Report on the Lands of the Arid Region of the United States with a More Detailed Account of the Lands of Utah*, Washington, DC, U.S. Govt. Print. Off., 1878.

possession of the government; the farmers owning the favorable spots could not obtain possession of the adjacent lands by homestead or preemption methods, and if such adjacent lands were offered for sale, they could not afford to pay the Government price.

Powell's fears were justified. Congress did not totally reform the land disposal laws. Instead, they gradually increased the amount of land that could be acquired, each time offering a larger but still inadequate parcel of land.

Early 1900's Homestead Legislation. The enlarged Homestead Act of 1909 increased the homestead size to 320 acres in nine western States and provided that one-fourth of the land should be cultivated. However, as 320 acres were still inadequate to support a family, the act only led to further expansion of settlement into areas where farming was ecologically unsound. In 1912 Congress passed the 3-year Homestead Act of 1912, which shortened the required residence period to 3 years but failed to address the need for increased acreage.

In 1916 the Stock-raising Homestead Act was passed to encourage the settlement of those western lands not suited for cultivation. The act gave stockmen 640 acres, a square mile of land that was supposed to be large enough to carry 50 head of cattle. In reality, most areas of the West would carry 10 head or less a square mile on a sustained yield basis. With the size of range homesteads so grossly inadequate, less than half of the stock-raising homesteads were patented during the first 10 years that the act was in effect.[2]

Deterioration of Arid Lands. Despite Powell's warning, the land laws of our country contributed directly to the deterioration of the arid lands. The laws encouraged the settlers to convert good rangelands into poor croplands and to overstock rangelands. During the same period there were no regulations governing use of the public domain. Vast, landless livestock herds developed throughout the West. The result was severe depletion and erosion of land, and actual starvation among the settlers. The policies of the Federal Government to move the public lands into private ownership were inadequate. Other movements were afoot to establish reserves, or reservations, for various single uses of the public lands. Yellowstone National Park was established as a national reserve in 1872, and the setting aside of lands for parks and monuments continues to the present time.

Forest Legislation. The Forest Reserve Act of 1891 established a series of National Forest reserves separate from the remainder of the public domain. Later legislation, the Forest Reserve Act of 1897, provided for the administration and development of policies for the management of timber, forage, and other multiple uses. The authority to regulate use of the National Forests was included in the Organic Act of June 4, 1897. Regulations for administering these uses,

[2] L. Stoddart, Arthur D. Smith, and Thadis W. Box, *Range Management*, 3rd ed., New York, McGraw-Hill Book Co., 1975.

Settlements depend on what little water is produced in the dry mountains of the arid lands. Good watershed management is especially important.

including timber production and grazing, were initiated during the early part of the 20th century.

During the 1905 to 1930 period, many rules, regulations, and procedures were established for the orderly removal of timber, forage, wildlife, and other products from these public lands. However, most of these public lands were in the high-elevation and more humid portions of the arid regions of the West. The truly arid regions remained in the public domain, and use on them was not controlled.

General Land Office. All other matters dealing with the public domain were handled by the General Land Office. During the years following its establishment in 1812, it was devoted primarily to the disposition of the public domain. Later it administered the establishment of mineral leases and other land-oriented matters. It was not until the passage of the Taylor Grazing Act in 1934 that other uses on the public domain, such as grazing, came under control.

Public Management. Today the Forest Service manages about 25 percent of the public land, the Bureau of Land Management, about 62 percent, and the National Park Service, 4 percent. Other agencies managing the public domain include the U.S. Fish and Wildlife Service and the U.S. Department of Defense. The U.S. Fish and Wildlife Service has about 4.8 million acres of land reserved for specific uses dealing with the protection of wildlife habitat. The Department of Defense manages an area about equal in size to that of the Fish and Wildlife Service. It is held for such things as military bases or bombing ranges and is not part of the land generally available to the public. Other agencies, such as the Bureau of Reclamation, Bureau of Mines, and Energy Research and Development Agency, have small amounts of land reserved for specific purposes.

Arid Lands Today

The cities of Denver, Albuquerque, Salt Lake City, Tucson, Phoenix, Las Vegas, and Boise dominate the arid region. They have developed into regional trade or retirement centers based primarily on mineral wealth or esthetic attributes. Capital from outside the arid region controls the politics and future of these metropolitan areas. They, in turn, control the destiny of the irrigable lands, the timber lands, and the pasturage lands.

Arable Lands. Small strips and fingers of arable lands were developed along the water courses and foothills where water is available. The establishment of farms and cities was geared directly to the amount and location of the water. Thus, as Powell has predicted, it was water, not land, that has determined how the West developed. Even after a hundred years, only small portions of the Western States are in private ownership.

Timber Regions. The high-elevation lands in America's arid West are largely in National Forests. They are managed under multiple-use objectives and their condition is highly variable from district to district. Most of them are more important for watersheds and recreation than for the traditional production of timber and forage. Much of the easily accessible old-growth timber was cut soon after settlement of the West, before the establishment of the National Forests. Timber was essential for housing and for the goods and services needed to support the early settlement.

The pasturage lands are in the best condition they have been in this century. Although there are still some areas in poor condition, scientific range management has been applied and, on balance, they have improved.

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How Land Is Used

Roger W. Hexem,
agricultural economist,
Economic Research Service

Angus cattle graze on range near Choteau, Montana. Grazing is the predominant use of U.S. agricultural land. (Tim McCabe, SCS, MT-10,255)

The Nation's land use has shifted slightly from agricultural to nonagricultural over the past several decades. Nearly one of every two acres—47 percent of all land—was in agricultural uses in 1982, the most recent estimate available. In comparison, about 52 percent was in agricultural uses in 1910 and 49 percent in 1950 including Alaska and Hawaii which became States in 1959.

Agricultural Uses

Over 60 percent of all agricultural land was in pasture and range in 1982. Permanent pasture and range accounted for nearly 600 million acres. Another 65 million acres of cropland were in pasture as part of crop rotations. About 158 million acres of forest land also were grazed and are included in nonagricultural uses.

Cropland was the other principal

Wheat is harvested near Pullman, Washington. It is the leading crop in that State. (Doug Wilson, 0983X1265-18)

use. Cropland used for crops totaled 383 million acres, representing about one-third of all agricultural land. Another 21 million acres of cropland were idle, and 8 million acres used for farmsteads and farm roads.

Nonagricultural Uses

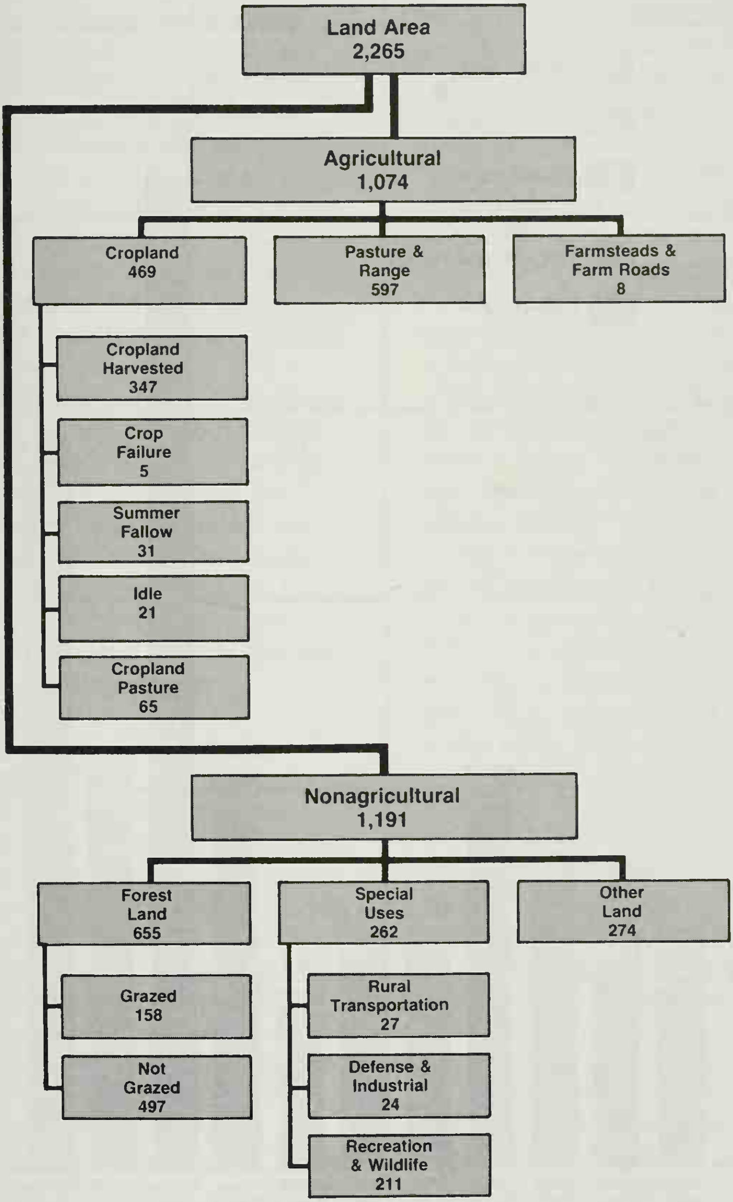
About 655 million of the 1,191 million acres of nonagricultural land was inventoried as forest land in 1982. Another 211 million acres were in recreational uses such as national and State parks, wildlife refuges, and national wilderness areas. Rural transportation systems accounted for 27 million acres, national defense and industrial areas for 24 million acres, and "other land" including urban areas, wetlands, deserts, and tundra for 274 million acres.

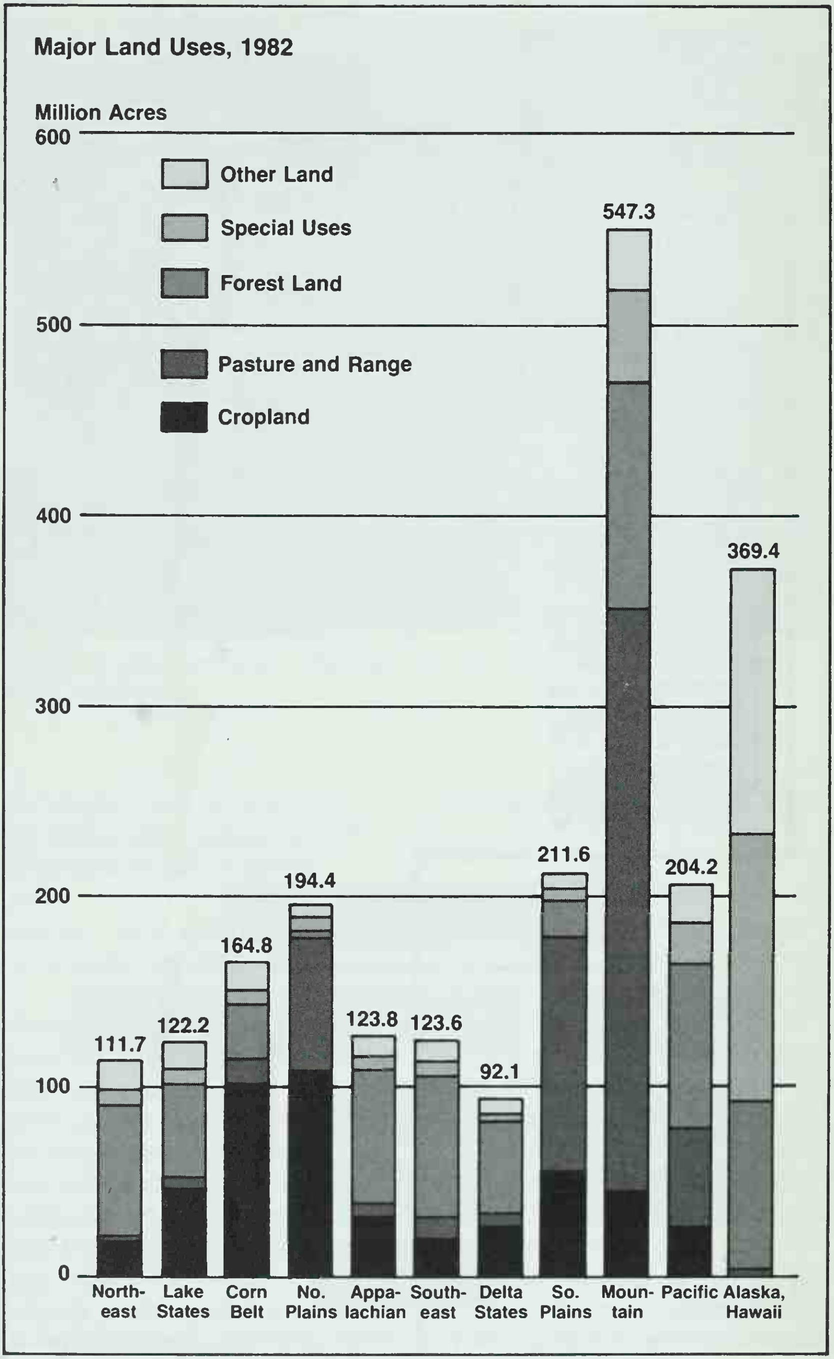
Regional Variations

Resources and climate strongly influence land-use patterns. The Corn Belt and Northern Plains regions have soils and growing conditions favorable to crop production. These two regions contained nearly 45 percent of all cropland in 1982 but only 16 percent of the total land area. In comparison, the Mountain region had one-fourth of all land but less than 10 percent of all cropland.

Pasture and range was the predominant use in the Southern Plains (122 million) and the Mountain region

United States, 1982—Million Acres


Land Area
2,265
Agricultural
1,074
Cropland
469
Pasture & Range
597
Farmsteads & Farm Roads
8
Cropland Harvested
347
Crop Failure
5
Summer Fallow
31
Idle
21
Cropland Pasture
65
Nonagricultural
1,191
Forest Land
655
Special Uses
262
Other Land
274
Grazed
158
Not Grazed
497
Rural Transportation
27
Defense & Industrial
24
Recreation & Wildlife
211


Major Land Uses, 1982
Million Acres
600
500
400
300
200
100
0
Other Land
Special Uses
Forest Land
Pasture and Range
Cropland
111.7
122.2
164.8
194.4
123.8
123.6
92.1
211.6
547.3
204.2
369.4
North-east
Lake States
Corn Belt
No. Plains
Appa-lachian
South-east
Delta States
So. Plains
Moun-tain
Pacific
Alaska, Hawaii

(305 million). The two regions accounted for more than 70 percent of all pasture and range and one-third of all land. Large acreages of grazing land also were inventoried in the Northern Plains and Pacific regions.

Acreage in forest land was distributed more uniformly. Largest acreages were located in the Mountain (120 million) and Pacific (85 million) regions and in Alaska (87 million). Forest acreage was not significant in the Northern Plains and relatively minor in the Corn Belt and Southern Plains.

More than half the U.S. acreage in State and national parks, wilderness areas, wildlife refuges, and national defense and industrial areas was located in Alaska and another one-fourth in the Mountain and Pacific regions. These three areas also had nearly 70 percent of "other land uses," principally wetlands, bare rock areas, deserts, and tundra.

U.S. Land-Use Changes Since 1950

Economic conditions have varied widely over the past three decades. At times, Federal farm programs have been implemented to decrease acreage in crop production and, at other times, to increase acreage. Conversions to nonagricultural uses have continued. Federal and State legislation to create or expand park systems, wilderness areas, and wildlife refuges has mandated land-use changes.

Cropland acreage decreased 9 million acres from 478 million acres in 1950 to 469 million acres in 1982. As already noted, however, percentages in cropland have remained almost unchanged. No cropland was diverted from production in 1950, but 22 million acres were diverted in 1959 and 58 million in 1969. Acreages in idle cropland, cropland pasture, and, to a lesser extent, cultivated summer fallow increased during these years while cropland harvested acreage declined. As cost-price relationships improved in the late 1970's and export markets expanded, fewer acres were idled and some cropland pasture was converted to crop production. By 1982, harvested acreage increased to 347 million, nearly the same as in 1950. About 11 million acres were diverted from production under Federal farm programs in 1982.

Largest acreage reductions during 1950 to 1982 occurred in pasture and range and in forest land. Some was converted to cropland, but most was reclassified to special uses, particularly park systems, wilderness areas, and wildlife refuges, which increased from 107 million acres in 1950 to 262 million acres in 1982.

Regional Changes

Although fewer acres were in cropland at the national level in 1982 than in 1950, acreages were higher in several regions. Largest expansions were realized in the Corn Belt (4.5 million), the Northern Plains (6.3 million), and the Mountain region (4.2 million). Cropland pasture and permanent pasture and range were converted to crop production in all three regions.

The Northeast, Appalachian, and

Southeast regions all had significant reductions in cropland acreage. Conversions of cropland to urban and other nonagricultural uses in the Northeast and Southeast contributed to reductions in cropland acreage being about 30 percent below 1950 levels. Some cropland was also shifted to pasture in the southeast. Cropland acreage declined nearly 20 percent in the Appalachian region, principally through conversions to forest land.

Regional change in agricultural uses varied even more widely than changes in cropland. Nearly 40 million fewer acres were in agricultural uses in the Mountain region by 1982 following reclassification of large acreages in pasture and range to special uses and "other land." Similar changes occurred in the Pacific region where nearly 10 million fewer acres were in agricultural uses. Agricultural acreage also was down in the Northeast (12.4 million) and in the Appalachian region (10.1 million) where cropland and pasture were shifted to or reverted to forest land. Acreage was higher in the Southern Plains (28.9 million) and the Delta States (1.9 million) as forest land was cleared for cropland and pasture.

Changes To Continue

Land-use changes will continue as economic conditions for competing uses of land vary and as governmental programs and policies affecting land-use decisions are altered.

Concerning use of agricultural land, the Conservation Reserve Program within the Food Security Act of 1985 has targeted 45 million acres of highly erodible cropland for conversion to soil-conserving uses by 1990. Landowners contract to keep cropland in conserving uses for 10 years. At least 5 million of the 45 million acres are to be planted to trees. Experiences with the Soil Bank Program of the 1950's and other longer term cropland retirement programs suggest that some of this former cropland will remain in permanent vegetation. The sodbuster provision of the 1985 act and recent changes in the U.S. tax code will tend to discourage conversions of pasture and forest land to cropland.

Conversions to urban and other nonagricultural uses will continue. Legislation to protect and preserve agricultural land will discourage and, in some situations, prohibit such conversions. Legislation to expand park systems, wildlife refuges, and wilderness areas is likely.

Agriculture and Urban Areas in Perspective

Ralph E. Heimlich,
agricultural economist,
Economic Research Service

Urban areas have the paradoxical distinction of being both the most important and least important land in the United States.

Most Yet Least Important

Urban areas are among our most important land because the majority of us live and work in them. Another reason that urban land is important is that, once converted from rural to urban uses, land rarely reverts to a less developed use. Thus, losses of cropland or forest to urbanization constitute a permanent, irreversible loss of agricultural capacity.

The transformation of the United States from an agrarian Nation to a Nation of cities, occurring within living memory, also has magnified our perceptions of the extent and importance of such land use shifts. The paradox lies in the fact that urban areas are relatively unimportant because they are a small fraction of the Nation's total land area.

Proximity

That some of our most vibrant and valuable agriculture occurs in the city's shadow also seems paradoxical. More than one-quarter of all farms are located in our metropolitan areas and produce 29 percent of the total value of agricultural production. Urban pressures on city farmers have resulted in adaptations that distinguish their operations from those of their country cousins, making urban agriculture more fit to survive current troubles in the agricultural economy.

Urban Geography

Geographers at the Bureau of the Census distinguish a variety of areas, ranging from 30,685 minor civil divisions and county census divisions up to 21 Consolidated Metropolitan Statistical Areas (CMSA's), each containing more than a million people. The two most common area delineations serve quite different purposes. An Urbanized Area includes a central city and adjacent densely settled places that together have a population of at least 50,000 persons. These areas coincide with land actually converted to urban uses as closely as possible.

On the other hand, Metropolitan Statistical Areas (MSA's) consist of counties with one or more Urbanized Areas and those outlying counties that demonstrate a high degree of economic and social integration with and dependence on the nucleus. MSA's thus reflect the reach of the city's influence, but contain a majority of land that is in essentially rural uses.

While the MSA's overstate the extent of urbanization, Urbanized Area understates the degree to which the city's social and economic influences affect land use patterns. Correct use of these constructs helps avoid errors about the extent of farmland loss and conflicts between urbanization and agriculture.

Where We Live and Work

Americans are disproportionately aware of metropolitan areas because more than three-quarters of us live in them. More than 80 percent of nonfarm jobs are located in metropolitan areas, and the same proportion of personal income accrues to people living in them. Yet only 714 counties (23 percent) are designated metropolitan, and they make up only 16 percent of total U.S. land area. Only about 10 percent of metropolitan area is actually in urban land uses, with the remaining 90 percent rural in character with substantial areas in farm and forest land.

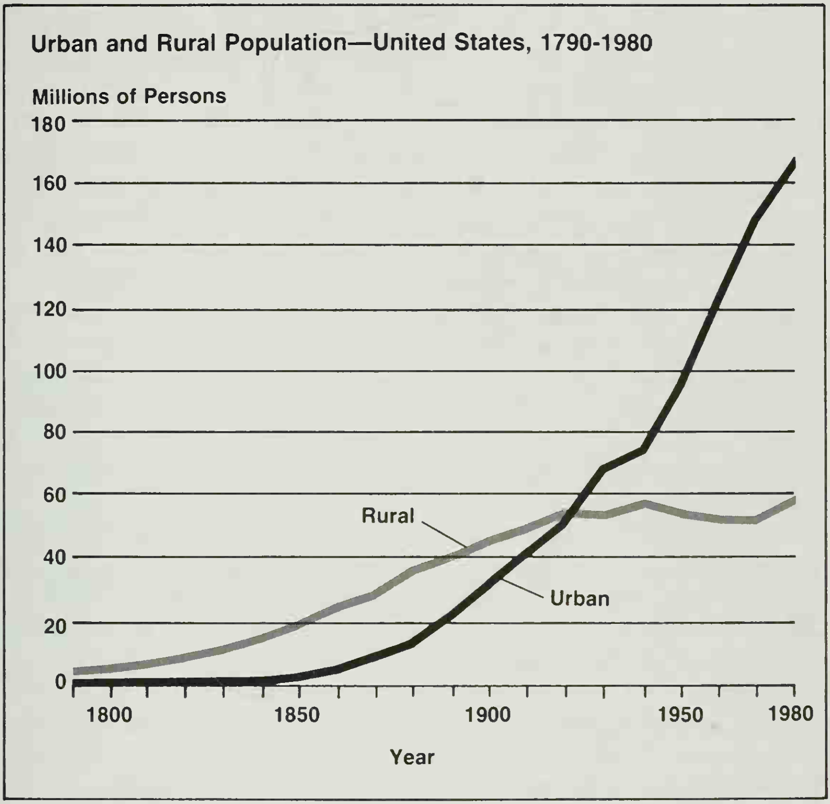
If we focus more strictly on land actually in urban uses, about 60 percent of us live within these Urbanized Areas. Our homes, businesses, and institutions take up surprisingly little room since Urbanized Areas account for only about 1.5 percent of total land area, little more than 1 quarter of an acre a person. While we are an overwhelmingly urban people, fewer than 30 percent of us live in central cities, the traditional city environments. Central cities occupy less than 1 percent of our land. All our Urbanized Areas would fit comfortably in an area the size of North Carolina and the central cities occupy land area smaller than West Virginia.

Two Centuries of Urban Growth

Only 1 person in 20 in the United States lived in urban areas when the Constitution was signed two centuries ago, although many of the urban areas of that period would more closely resemble small towns of today than the Urbanized Areas. Urban population rose steadily until 1930, leveled off during the Depression and war years, and has risen at a rapid rate since 1950.

The exponential growth in urban population since 1920 was accomplished through immigration, natural increase, and movement off the farms. Despite massive migration from farms to the cities during and after both World Wars, rural population was higher in 1980 than at any time in the past 200 years.

Growth in urban land area has been as dramatic as growth in urban population, almost doubling since World War II. However, urban areas (including small cities) still accounted for only 2 percent of total land in 1980. Metropolitan areas more than tripled in size over the post-war period due to development of housing, shopping centers, and commercial and



Urban and Rural Population—United States, 1790-1980

industrial facilities in previously rural counties. However, the inclusion of rural areas is characteristic of growth in metropolitan land area since large portions of the county components which define MSA's are not urbanized.

Changes in urban and metropolitan definitions reflect the growing extent of urban influence on rural areas, but the growing amount of land in MSA's gives an increasingly inaccurate picture of actual growth in urban land uses. Rural land uses are being incorporated into our metropolitan areas, but not necessarily being replaced by urban land uses.

Cropland Changes

Changing definitions of metropolitan and urban areas have had little effect on our cropland base. Cropland used for crop production declined slowly over the post-war period in response to chronic surpluses, until the short-lived agricultural export boom of the mid-1970's. Total cropland peaked in 1982 at a level reached only twice before, in 1932 and 1949, despite large increases in metropolitan and urban areas.

While metropolitan area is now almost as great as cropland used for crops, land continues to be cropped within metropolitan areas. Because defined metropolitan areas include rural land, about one-fifth of harvested cropland is in metropolitan areas. Major shifts in the location of land used for crops have occurred over this century, but cropland lost to urban development has been made up by new cropland development.

Losses of rural land to urban uses continue and may have accelerated with the resurgence of commercial and residential construction brought about by lower interest rates since 1982. In some cases, urbanization may affect national production of specialty fruit or vegetable crops, but generally has little effect on national supplies of most agricultural products. These land use changes, however, have important local implications because of impacts on open space, water quality, urban flooding, and rural lifestyles. Urbanization creates problems for farmers in getting along with their new neighbors, getting along without key support services such as feed, seed, and supply dealers, and putting up with higher property taxes.

Concern over urbanization of farmland by both urban and rural constituencies led to farmland retention legislation as early as 1956. Preferential tax assessment for farmland has been enacted in all States, and 47 States assess farmland at its value in agricultural use. Some 46 States have "right to farm" laws, agricultural districting is authorized in 12 States, and purchase or transfer of development rights on farmland has been legislated in 6 States. Nationally, a Farmland Protection Policy Act was passed as part of 1981 farm legislation.

Farming in the City's Shadow

Agriculture is still an important land use in the nine-tenths of our metropolitan area that is not urbanized. More than one-quarter of all farms in 1982 were located in metropolitan counties, including almost 30 percent of our family farms. A majority of our horticulture specialty, fruit, tree nut, vegetable and melon, and animal specialty farms are in the metropolitan areas, as well as a full range of other farm types. Some 16 percent of U.S. farmland is metropolitan, just proportional to metropolitan land area. Metropolitan farms are used more intensively, accounting for almost one-fifth of cropland harvested.

Farms in metropolitan areas tend to specialize in high-value crops, accounting for almost one-third of the market value of agricultural products sold on only a fifth of the cropland. About three-fourths of nursery and greenhouse products were produced in metropolitan counties as well as more than two-thirds of the vegetables, fruits, and nuts. Almost 60 percent of sales made directly to consumers through roadside stands and farmer's markets occur in metropolitan counties.

The combination of proximity to urbanizing areas and concentration on high-value, intensive agriculture results in high farmland values for metropolitan farmers. Farmland in urban fringe counties in 1986 averaged $2,669 an acre, while rural farmland was valued at only $613 an acre. Urban farmland

2 pounds
$1.00
Sweet!
Mix or Match
39

A Washington, DC, farmers' market brings locally grown produce to urban dwellers. (Jay Beavers, OGPA, 0986G1027-27) increased 6 percent in value between 1985 and 1986 while overall farmland value dropped 8 percent.

Between 1978 and 1982, the number of farms in metropolitan areas increased by 3.5 percent, while farm numbers dropped in nonmetropolitan areas. Land in metropolitan farms decreased, but harvested cropland remained constant and the value of sales, after adjusting for inflation, increased more for metropolitan farms than for nonmetropolitan ones.

City Farmer and Country Farmer

Metropolitan farming shares many of the characteristics of agriculture away from cities, but also has several attributes uniquely dependent on urban proximity. The average city farm has about half the land of the average country farm, but almost 40 percent is harvested cropland, compared with only 30 percent for nonmetropolitan farms.

A larger proportion of metropolitan farms fall in the minifarm and small farm categories than nonmetropolitan farms. Minifarms have less than $2,500 in sales and made up 30 percent of metropolitan farms in 1982, but only 20 percent of nonmetropolitan farms. Small farms, those making between $2,500 and $20,000 in sales, constituted about a third of all farms in both metro and nonmetro counties. Farms earning over $20,000 in sales were a larger proportion of farms in nonmetropolitan than in metropolitan counties. However, the very largest farms with over $250,000 in annual sales made up 4.1 percent of metro farms, but only 3.7 percent of nonmetro farms.

A smaller proportion of metropolitan farm operators list their occupation as farming, and more spend a substantial part of their time working off the farm than in nonmetropolitan areas. More than 60 percent of metropolitan farm operators are full owners of their farms, compared with only 56 percent for nonmetropolitan farmers. While the average metropolitan farm is smaller than the nonmetropolitan farm, a higher proportion is held in partnerships or corporations than for nonmetropolitan farms.

Implications

Our cities and towns are an important use of the land because most of us live in them, because they irrevocably change the landscape in ways that preclude other land uses, and because they are a relatively recent phenomenon in our predominantly agrarian history. Despite their importance, urban uses make up a small portion of our total land area. Land in metropolitan areas, even though in rural uses, is heavily influenced by urbanization.

Losses of rural land to urban uses continue to occur, with important local land use implications, prompting many States and localities to pass farmland retention legislation. With this protection and under economic pressures, agriculture in metropolitan areas has adapted to urbanization, resulting in smaller, more intensive operations growing higher value crops and livestock.

Urban farmers more often farm as a sideline, or supplement farm income with work opportunities in nearby communities. Many urban farmers have converted proximity to urban centers from a liability to an asset by focusing on consumer demands for fresher, high-quality produce grown locally using organic or reduced-chemical techniques. Such crops often command premium prices, but require development of nontraditional marketing channels.

The number of metropolitan farms, harvested cropland, and the value of agricultural production from them is more than proportional to metropolitan area, making farming in the city's shadow an unusually healthy part of our agricultural economy. Metropolitan farmland values, buoyed by high-value production and urban demands for land, have sustained their high levels during the recent decline in overall farmland values. By retaining equity in their land and depending less on government-supported crops, urban farmers spared themselves much of the distress felt in agriculture generally in recent years.

The combination of farmland retention programs and competitive adaptation has allowed farming to continue in metropolitan areas. These influences will continue to differentiate urban farms from the rest of U.S. agriculture and will insure that agriculture continues as an important part of our metropolitan landscape.

What Price Farmland?

William H. Heneberry and Charles H. Barnard,
agricultural economists, Land Economics Branch,
Economic Research Service

The fall in farmland values in the early 1980's was the first such major decline many farmers can remember. Except for slight setbacks in 1939, 1950, and 1954, values had risen steadily for nearly half a century, culminating in nine consecutive years (1973-1981) of double-digit annual increases in value. Understanding why farmland values change depends very much on understanding of how farmland itself has changed.

Early Estimates

Early in the Nation's history the efforts of the Federal Government to dispose of land and encourage private ownership greatly influenced land values. The Land Ordinance of 1785 required half the land to be sold as sections of 640 acres each. The minimum price was $1 an acre. While this minimum doubled by 1796, competition from States and individuals reselling their land kept values low for undeveloped land. By 1820, the minimum price had dropped to $1.25 an acre, and the minimum transactions involved 80 acres. These prices were for unimproved land close to its natural state.

The development of transportation systems influenced farmland value during this period. Improvements in river navigation, railroads, and wagon roads increased farmland values by improving the market for farm products and bringing in more settlers to develop the land and compete for farms already operating.

Farms in some Eastern States were declining in value by 1839 because of soil erosion and depletion of plant nutrients as well as competition from newly developed land farther west.

The 10-Year Census

The U.S. Department of Agriculture (USDA) using census data has estimated values for most States at 10-year intervals beginning in 1850. The census of 1850 reported many counties as having an average farmland value of less than $.50 an acre. In contrast, New York County, New York, had the highest average value, at $1,847 an acre.

The effects of the Civil War can be inferred from a comparison of the 1860 and 1870 estimates. Values fell by 50 percent during the decade in many parts of the South, while farmland increased in value in the Northern States during the same period.

Early 20th Century Values

USDA's annual estimates of value,

available from 1912 to the present, recorded the Nation's rising land market that led to the land boom of World War I. Land values rose gradually from an average of $40 an acre in 1910 to $43 in 1915. However, by 1920, primed by a prosperous agriculture, land was $69 an acre, 60 percent more than in 1915.

High farm commodity prices during World War I contributed to the optimism over land values, as American farmers supplied Europe, where the war had interrupted food production. While many stated that land would never be cheaper in 1919, a few observers warned that prices had risen above what farm income could support.

Falling Values, 1921-1933

Farmland values quickly reversed in 1921, as falling farm commodity prices pressured farmers and ended land speculation among nonfarmers. By 1928, values were 29 percent below their peak, and a much steeper decline began in 1930 with the onslaught of the Great Depression. Nationwide by 1933, values had dropped 39 percent below 1930 and 56 percent below the 1920 peak. In States where the land boom was biggest, the drop was even more drastic. After 1933, values leveled out and remained low throughout the decade.

Recovery, 1934-1960

Potential land buyers were wary of the improvement in agriculture and the economy in the 1940's. People remembered the "boom and bust" and feared a similar cycle after World War II. Lenders were cautious also, preferring to base loans well below the market value.

Nevertheless, values more than doubled from 1940 to 1950, and rose 80 percent from 1950 to 1960.

During the decade of the 1960's, American agriculture was relatively stable. In this economic climate, average farmland values rose an average compound increase of 5.1 percent annually.

The Seventies—Beginning of Volatility

An unprecedented rise in farmland prices occurred between 1972 and 1981 beginning with massive sales of U.S. grain to the Russians in 1972, and a whole series of events that led to expanded American farm exports and improved farm income.

Farmers and nonfarm investors bid up the price of land 23 percent during 1973. Farmland prices then increased by double digits every year until 1981. The largest regional increase was in the Corn Belt where values increased by 33 percent during 1976.

The climate was conducive to rising expectations and rising land values. Credit for land purchases was readily available, and mortgage interest rates were low relative to inflation and were actually outpaced by inflation in 1974 and 1975, creating negative real (inflation-adjusted) interest rates. Real interest rates averaged only 1.5 percent for the decade. The high rates of inflation in the general economy made

When farmland values increased in the 1970's, valuable Corn Belt land such as this partially harvested cornfield in Hamilton County, Nebraska, increased the most. When values dropped in the 1980's, Corn Belt land values dropped the most. (Gene Alexander, SCS, NEB-2267)

farmland a valuable inflation hedge and tax shelter, encouraging real estate purchases for investment and speculation. Additionally, during the second half of the seventies, rising commodity program loan rates substantially reduced the risk in much of agricultural production.

Overall, land values increased by 275 percent from 1972 to 1981, an average compound annual rate of 14.2 percent. In the Corn Belt, value rose from $406 an acre in 1972, the first year of double-digit increases in farmland values, to $1,776 in 1981.

Eighties

Expectations for continually increasing farmland earnings and inflation changed sharply in the early 1980's. New macroeconomic policy, particularly monetary policy, led to a dramatic reversal in inflation rates and a substantial rise in interest rates. High real interest rates strengthened the value of the dollar in international markets, boosting U.S. prices overseas and contributing to the reduction in the volume and value of agricultural exports as U.S. prices became less competitive.

Declining exports, in turn, led to surplus domestic stocks, lower commodity prices, and lower farm incomes. In 1980, net farm income fell nearly $11 billion from 1979, largely because of higher interest rates, higher costs of manufactured farm inputs, and lower cattle prices. The continued decline in U.S. farm exports also contributed to a more pessimistic outlook for farmland values.

By early 1987, farm real estate values had fallen by percentages unprecedented since the Great Depression. Nominal values had fallen 33 percent in the 48 contiguous States and a spectacular 54 percent in the Corn Belt. Adjusted for inflation, real land values fell 47 percent below the 1980 peak. In the Corn Belt, the average real value was only 35 percent of the 1980 peak for the region.

Outlook

As of mid-1987, the dollar declined on world markets, holding out the possibility of greater export volume and higher commodity prices, but also the possibility of higher interest rates. Farm income was at an all-time high, but an unprecedented proportion of that income was from government payments.

And farm expenses had fallen for 3 years running, for the first time in memory. The declining expenses were due, in part, to lower energy costs and, in part, to the Conservation Reserve Program, intended to idle as much as 45 million acres under 10-year contracts. The farm programs continued to be in flux, leading to uncertainty about the direction and level of farm returns.

Wildlife Values Serve People, Too

Laurence R. Jahn, president,
Wildlife Management Institute, Washington, DC, and
Keith W. Harmon, western field representative,
Wildlife Management Institute, Hickman, NE

Migrating geese stop at the wetlands of the Blackwater Wild Geese Refuge near Cambridge, Maryland. (Don Schuhart, SCS, 0976X1193-13)

No doubt about it. Population growth puts pressure on land, water, and wildlife resources. They need more protection than they are getting, but like other great national assets, they must produce benefits for the public, too. Soil erosion, loss of wetlands, irresponsible conversion of western rangelands, and pollution are much in the news, giving emphasis to why natural resources should be viewed, used, and managed differently.

An integrated approach to natural resources management helps to sustain rather than degrade our resource base. The public supports changes in management policy to accomplish this as evidenced by polls, in the efforts of organizations, and in the courts.

A sustained-yield, multiple-benefit doctrine of natural resource management is popular in many geographic areas as a way to reduce the exploitation of natural resources and curtail rising tax-supported costs. Today taxpayers are facing increasing costs to clean up contaminated sites, correct soil erosion, restore water quality in ground-water aquifers, rivers and lakes, and rebuild populations of threatened and endangered plant and animal species.

Policies for managing agricultural lands and aquatic areas, especially wetlands, have undergone dramatic change in recent years. Today, management objectives and guidelines recognize the dominant influence of people and their activities on all our natural resources. Always, they should perpetuate the public values and services of our resources.

Food Security Act

The Food Security Act of 1985 introduced a strong conservation initiative to reduce soil erosion, improve water quality and wildlife habitat, and make agricultural land use more self-sustaining. Unlike other Federal agricultural and conservation efforts of the past 50 years which have been marginally effective, the 1985 act uses a new approach. Certain agricultural subsidies no longer will be available to landowners and operators who allow erosion on their farms to continue beyond established standards and limits.

Soil Erosion

Intensive crop and tillage practices have yielded alarming rates of soil loss as well as overabundance. Tolerable soil erosion rates are considered to be not more than 5 tons an acre a year on deep soils and less than 3 tons on shallow soils. Parts of the Nation are losing soil at much higher rates—even more than 100 tons an acre a year. Such losses are a national disgrace and must be reduced substantially if cropping is to be continued on a sustainable basis.

New Procedures and Practices

The conservation provisions of the 1985 Food Security Act encourage land management practices designed to reduce soil erosion by 50 percent in a few years and assist farmers in making their operations more economically and environmentally sound by:

- removing up to 45 million acres of highly erodible lands from intensive cultivation through the "conservation reserve";
- preventing vegetated rangelands from being converted to cultivation through the "sodbuster" provision;
- withdrawing commodity (feed grain, wheat, rice, upland cotton, etc.) acreages from production through multiyear acreage set-asides;
- providing conservation easements for 50 or more years to cancel part of a farmer's debt where the farmer's

land is security for a Farmers Home Administration (FmHA) loan; and requiring farm plans to be developed for highly erodible lands by 1990 and management practices applied by 1995 to hold soil erosion within acceptable limits.

Conservation Reserve. In 1986 signups for the conservation reserve, landowners have responded favorably, and 20 percent of the 45 million acres have been enrolled in 10-year contracts in less than a year. Soils on these almost 9 million acres of highly erodible lands will be stabilized by planting grasses or trees. The remaining 80 percent of the 45 million acres should be enrolled by 1990.

Sodbuster and Swampbuster Provisions. Sodbuster and swampbuster provisions realign Federal assistance and prevent the U.S. Department of Agriculture (USDA) from assisting landowners who convert rangelands (grasslands) and wetlands to crop production. Government financial support for loans, crop insurance, disaster payments, etc., will be withheld.

Properly administered and in combination with recent U.S. tax code reform that eliminates fast writeoff of wetland drainage costs, swampbuster should help reduce the excessive rate of wetland conversion and loss from agricultural activities. In recent years, approximately 87 percent of the Nation's annual wetland loss of about 458,000 acres was associated with agricultural land uses. Tax law changes included denying financial advantages for converting wetlands to croplands. These swampbuster and tax code provisions should help keep the remaining 96-99 million-acre wetlands among the most diverse, productive, and unique areas in the world. More sensitive maintenance and management of wetlands will come about because of these changes and improvements already introduced in State wetland laws. Nevertheless, potential loopholes within these pioneering statutes could weaken their effectiveness if left uncorrected.

Conservation Easements. FmHA is moving to assist farmers in financial difficulty:

1. Guidelines and rules are being developed to identify loan procedures for using conservation easements of 50 years or longer to help farmers avoid foreclosure by restructuring farm indebtedness.
2. More than 1.7 million acres of foreclosed "inventory" lands now held by USDA are being screened to identify those with potential wildlife values and those for transfer to State wildlife agencies or the U.S. Fish and Wildlife Service for management.

Farm Law Evaluation

While the pioneering provisions of the Food Security Act raise expectations for effective conservation, questions remain over the long-term commitment of USDA, Soil Conservation Districts and their equivalent units of State Governments, local agricultural committees, and others on how the newly integrated agricultural programs will be executed. Are the commitments of personnel and land operators, as well as the design of existing institutions and procedures, adequate to ensure that what is called for in law will be translated on the land?

Multiyear Acreage Set-Asides

The set-aside cropland diversion program has been executed on a year-by-year basis, frequently leaving landowners no time to put vegetative cover on the annual set-aside acreages. Therefore, vegetation to meet conservation objectives is missing. If 44 million acres under 1986 annual set-aside contracts were moved to multiyear contracts, that shift would yield substantial economic savings, as well as conservation benefits.

As shown through a computer model, for example, Minnesota's autumn pheasant population would increase from 1 million in 1986 to 5 million in 2 to 3 years under vegetated set-aside acreages. And, under the best of predicted habitat conditions under multiyear set-asides and 10-year conservation reserve, possibly the autumn pheasant population would increase up to 9 million in 5 to 7 years. Such increases would provide abundant hunting opportunities and help stimulate the economy of depressed agricultural areas.

The past five decades illustrate the advantages and benefits of long-term (up to 10 years) agreements both to landowners and the land as well as to wildlife populations.

In sharp contrast, annual land agreements with USDA, which do not require that vegetation be established, offer minimal or temporary conservation and wildlife benefits.

Changes in Bird Population

Intensively cropped and thereby degraded lands support correspondingly reduced wildlife populations of desirable birds. In Illinois, for example, patch-type agricultural fields were expanded to become more uniform monocultures of crops between 1906 and 1958. Mockingbirds, brown thrashers, kingbirds, and bluebirds declined as fields became larger and more intensively used. Grackle, killdeer, and meadowlark numbers remained the same, while starlings and red-winged blackbirds increased. While overall bird numbers remained unchanged, the species composition changed substantially.

In wheat- and feed-grain-producing areas, the impact of intensive agriculture on some wildlife populations is substantial. In the 1940's, a typical section (640 acres) of land in Wood County, Ohio, had about 30 percent row crops, with other fields in legumes and grasses. Twenty years later, 60–70 percent of the cropland was in row crops, with virtually none in legumes and grasses. A section of agricultural land that supported more than 300 pheasants under diversified farming in the 1940's, two decades later under more intensive monoculture accommodated only a few pheasants—the lowest density in the State.

Similar declines in pheasant densities took place in other geographic areas as agricultural cropping expanded and became more mechanized and chemically intensive.

Focus for Future

The current farm law may be the beginning of a shift toward more integrated commodity and conservation programs serving a much broader range of national interests.

Meanwhile, the degraded Chesapeake Bay, Lake Okeechobee in Florida, Lake Michigan, and other public waters of the country await improved land management and restoration so that these great resources can contribute fully to the economy.

Right now we, as a Nation, want expansion of agricultural trade to help our economy. That worthy desire should be tempered with a commitment not to infringe on vital land and water resources necessary to achieve sound conservation and wildlife objectives.

The pressing needs and opportunities are to continue to design and conduct a national agricultural program that places commodity production on a sustainable basis and ensures multiple benefits, including wildlife, to help maintain a strong economy.

Conserving Land

Part V

The Creek That Slumbered 40 Years

Mark E. Moseley, range conservationist,
Soil Conservation Service,
San Angelo, TX

West Rocky Creek is a tributary of the Middle Concho River in the Edwards Plateau region of West Texas about 20 miles west of San Angelo. Shallow soils formed over limestone and caliche characterize the area as does the average annual rainfall of 18 inches.

Once the creek flowed year round, then during the drought of 1918–1919 it ran dry for the first time and became an intermittent stream. Matters steadily grew worse until the creek dried up completely by 1935.

Originally any rainfall that soaked into the ground below the depth of the grasses recharged aquifers on the watershed. But, with a decline in the quality of the ground cover, roots used all the water that escaped the grasses. Water no longer fed the aquifer to emerge as a spring. Brush was the enemy. Mesquite's lateral roots extend as far as 150 feet to sap crops.

Dormant bud zones on the base of mesquite and juniper make them difficult to kill. If a tree is damaged by a rancher trying to eliminate it, the buds take revenge by sprouting a dense second growth not only more difficult to kill, but taking up more water than the original tree.

Juniper, which was first noted in the area as being near a 1901 Rocky Creek landmark, has grown to a dense stand that challenges control and defies elimination. The turn of the century was about the time that juniper and mesquite began replacing productive grasses and nutritious forbs there. First the brush invaded the deeper soils, then moved up the draws to the hillside. Livestock and wildlife contributed to the spread through their feeding patterns. Streamflow decreased in proportion to the brush invasion. Prairie fire, controlled by settlers, no longer killed seeding brush to restore grassland balance. Droughts hastened the process of transforming the West Rocky Creek prairie to a brush-infested rangeland.

It remained so until the 1960's when something equivalent to the fairy tale of the princess kissing the frog took place.

Landowners on five ranches, covering about half the 74,000-acre watershed of West Rocky Creek, began a conservation effort that quite unex-

Range conservation work by local ranchers brought West Rocky Creek in western Texas back to life again after almost 30 years as a dead stream. (Mark Moseley, SCS)

pectedly restored the streamflow. They accelerated range conservation on their land—rootplowing, reseeding, treedozing, chaining, aerial spraying, and grazing their livestock according to a carefully planned system. Along with their own money the ranchers used technical assistance and cost sharing from the Great Plains Conservation Program.

The unexpected stream regeneration occurred in 1964, following a large amount of rootplowing. Rancher George Skeete noticed a spring that had not been active since he bought the ranch in 1935. By 1970, the headsprings were flowing through the Skeete Ranch for the first time in anyone's memory and springs had begun on all five ranches where the conservation effort was underway. Streamflow grew in West Rocky Creek to range from a low of 150 gallons a minute during drought to a high of 4,000 gallons a minute.

While Rocky Creek is not the only dead stream to reappear following intensive watershed conservation, it is one of the largest and most successful examples. Other experiences have shown that not every dried up watershed can respond to land treatment like Rocky Creek. The geology has to be favorable and historic evidence of streamflow present. Today the West Rocky Creek watershed benefits the municipal water supply reservoir for the city of San Angelo in addition to reducing erosion and increasing forage for the ranchers' wildlife and livestock. San Angelo, population of 80,000, depends on surface reservoirs for its water. West Rocky Creek provides almost 10 percent of the city's needs while taking up only 3 percent of the watershed above San Angelo.

Lakes in the area no longer fill rapidly with sediment. Wildlife thrives because of stable water supplies and the prescribed cover arrived at through good brush management.

What happened to one small creek in West Texas typifies what can be done with range management elsewhere under similar conditions. Other municipalities considering cloud seeding, dam building and well drilling to increase their water supplies also should look to partnerships with their area landowners on watersheds with good land treatment potential. They may find range conservation the most environmentally sound and inexpensive route to improving municipal water supplies.

Strong, New Incentives To Complete Conservation Plans

Karl H. Reinhardt,
soil conservationist, Soil Conservation Service

Helping people solve soil and water resource problems is the major work of the Soil Conservation Service (SCS). SCS employees have assisted land users in preparing and applying conservation plans for more than 50 years. SCS assistance is based on conservation planning—a process now made especially important by the provisions of the Food Security Act of 1985.

The Food Security Act of 1985

The Food Security Act (FSA) of 1985 includes conservation plans in Federal legislation for the first time. Producers who intend to continue cropping highly erodible land must produce their crops according to a conservation system in order to remain eligible for certain U.S. Department of Agriculture program benefits. All such producers must develop a conservation plan by January 1, 1990, and all the erosion control practices must be installed by January 1, 1995.

Although conservation plans have been used previously as the basis for longterm contracts to apply conservation practices, as in the Great Plains Conservation Program, the FSA goes beyond a contract and requires the producer to use the conservation plan for the indefinite future to maintain eligibility.

In view of the FSA requirements, SCS will need to help develop new conservation plans with about half of the participating producers and review and possibly revise the existing conservation plans of others before the January 1, 1990 deadline.

Conservation Planning

The conservation planning process is the same whether it is used with an individual landowner, a group of landowners, or a city council. However, most conservation plans are developed with individual farm or ranch owners or operators or small groups of them to help solve one or more common problems.

The conservation planning process is based on the producer being the decisionmaker. The SCS employee presents several alternative solutions to the resource problems, complete with costs and benefits, to the producer/cooperator. If producers recognize their resource problems and

Contour stripcropping, a conservation practice, controls soil erosion in this Iowa cornfield. A soil conservationist (left) and farmer review the conservation plan for the farm. (Gene Alexander, SCS)

can choose from among several alternative solutions, any one of which meets their objectives for the use of the land, then they will develop and apply the conservation plan.

Through the past 20 years, SCS has helped conservation district cooperators develop an average of 60,000 conservation plans on 23 million acres a year. In 1983 conservation plans were developed for a peak of 37 million acres. These acres are not cumulative because many farms change hands and new plans are developed with the new owners.

After the planned conservation practices are applied, they must be maintained to be sure that the benefits of the investment in conservation are fully realized. Technical assistance may be needed from time to time to help the producer consider the best way to carry out the maintenance work and also ways to avoid or reduce future maintenance requirements. The amount of maintenance needed by a conservation practice should be considered before selecting the practice.

Conservation plans must be revised as technology, markets, and export needs change. The conservation planning process is flexible enough to permit the development of a revised plan that usually becomes necessary because of a change in the producer's objectives.

Resource Management Systems

SCS employees encourage the land user to plan and apply conservation treatments that will fully protect the soil and water resources. This protection is provided by installing and maintaining Resource Management Systems.

A resource management system is a combination of conservation practices and management measures that, when applied to the land, will protect the soil, water, and related resources. A conservation plan can show how such a system may be installed. If all agricultural fields had resource management systems, soil erosion rates would be reduced and the Nation's productive capacity would be assured. In addition to reducing erosion, resource management systems deal with five other resource concerns.

Resource Concerns

"Resource concerns" is a term used to categorize the kinds of soil and water resource problems that any land use can introduce. The concept of resource concerns was established to ensure that all of the existing soil and water resource problems would be identified and addressed in the conservation planning process. The concept enables the conservationist to quantify just how well a problem has been solved or alleviated.

The major resource concerns are:

- Erosion control
- Water disposal
- Animal wastes and agricultural chemical management
- Resource management
- Water management
- Offsite effects

All soil and water resource problems fall within these six resource concerns.

When all of the identified resource concerns on a land unit have been treated to reach their respective acceptable levels of quality, a resource management system is in place. A conservation system for FSA purposes requires only that the erosion control resource concern be treated.

The FSA Spurs Plan Development

Conservation plans have changed in format and degree of detail needed as agriculture, land use, and farmers' objectives have changed. The current effort is to facilitate the development of conservation plans so that all the farmers and ranchers who will need conservation plans to meet FSA requirements can have their plans developed quickly. This will mean working with farmers in neighborhood groups, having farmers do some of the map work for their plans, and keeping documentation to a minimum.

The concepts of understanding the problem, considering alternate solutions, and selecting the best of the solutions are the heart of any planning process. This approach continues to be essential in carrying out soil and water conservation programs.

Conservation Tillage—a Hot, New Idea From the Distant Past

Richard S. Magleby, agricultural economist,
Economic Research Service, and
David L. Schertz, national agronomist, Soil Conservation Service

USDA has tracked conservation tillage adoption since 1963, when it was practiced on less than 1 percent of the planted cropland. Ten years later in 1973, conservation tillage was used on nearly 5 percent of the planted acres. By 1983, after 20 years, use of conservation tillage had grown to over 20 percent of the planted cropland. In 1986 conservation tillage was practiced on nearly one-third of our Nation's planted cropland areas and has become one of America's most widely used conservation practices.

The primary difference between conservation tillage and conventional tillage is the percent of soil surface covered by crop residue after planting. Conservation tillage is any tillage and planting system in which at least 30 percent of the soil surface is covered by plant residue after planting (to reduce soil erosion by water). Where wind erosion is the primary concern, at least 1,000 pounds an acre of flat small grain residue-equivalent should be on the surface. Under conventional tillage, fields are plowed with a moldboard plow or otherwise worked sufficiently to cover all or nearly all of the previous crop residue. With conservation tillage, specialized equipment is usually needed.

Major Types

1. *No-till:* The soil is left undisturbed before planting, which is completed in a narrow seedbed. Weeds are usually controlled with herbicides.

2. *Ridge-till:* The soil is left undisturbed before planting, which is completed in a seedbed prepared on ridges with sweeps or row cleaners. Weeds are usually controlled with herbicides and cultivation. Cultivation rebuilds ridges.

3. *Strip-till:* The soil is left undisturbed before planting. Tillage in the row at planting time may consist of a rototiller, in-row chisel, row cleaners, and so forth. Weeds are usually controlled with herbicides and cultivation.

4. *Mulch-till or reduced-till:* The total soil surface is disturbed by tillage before planting. The same equipment used in conventional tillage (except the moldboard plow) can be used such

On a no-till system in Iowa, soybeans emerge through corn residue. (Gene Alexander, SCS, IA-2,853)

as chisels, field cultivators, discs, sweeps, or blades but with less frequency. Weeds are usually controlled with herbicides and cultivation.

Soil Erosion Slowed

Of the four types of conservation tillage, no-till leaves the most plant residue on the soil surface after planting and conserves the most soil. Depending on the previous crop, no-till leaves the total surface covered by residue. If crops such as soybeans and cotton produce insufficient residue, cover crops are often used to increase it. Although erosion effectiveness will vary, no-till usually achieves a greater than 75 percent reduction in soil loss compared with conventional tillage.

Ridge-till, strip-till, and mulch-till, which leave less residue than no-till, are less effective, but still reduce erosion from 50 to 75 percent from conventional tillage levels.

Popular in the Corn Belt

The Corn Belt has both the largest acreage of any region—34 million acres—and the highest proportion of its cropland, 43 percent, using conservation tillage.

Reasons for regional differences in how much conservation tillage is practiced may be the major crops that are grown and differences in soil and climatic conditions. The residue requirement for conservation tillage is easier to achieve with high residue crops such as corn and small grains than with low residue crops such as cotton, peanuts, and soybeans. Also, where cover crops are needed to supply sufficient residue cover to meet the definition of conservation tillage, the cover crop may use stored soil

Regional use of conservation tillage, 1986

Region	Acres in conservation tillage	Percentage of cropland in conservation tillage
	Millions	Percent
Corn Belt	33.7	43
Appalachian	6.0	40
Northeast	3.5	40
Mountain	8.2	36
Northern Plains	23.6	36
Lake States	8.4	27
Southeast	2.3	21
Southern Plains	6.6	20
Pacific	2.6	19
Delta	2.6	15
Total United States	97.5	33

Source: Conservation Technology Information Center

moisture resulting in less reserve moisture for the primary crop. Cover crops may not be a viable alternative to increasing surface residue in low rainfall areas.

Other reasons for differences among cropping regions include soil and climate. Negative conditions, however, are often overcome by proper management, changes or shifts in cropping patterns, and use of improved technology.

A major advantage of conservation tillage in areas of the Northern Plains with winter-seeded small grain has been to keep soil temperatures in the winter from going below the threshold level where the crop is severely damaged. Plant residue on the soil surface also significantly increases snowpack, thereby storing more soil moisture for the next crop. In fact, conservation tillage makes annual cropping possible in many areas of the Northern Plains. Without the practice, the land generally is fallowed every other year to rebuild moisture.

Promising for Irrigated Land

The adoption of conservation tillage on furrow irrigated land has been much slower than on nonirrigated areas. Many farmers are concerned that leaving plant residue on the surface will retard irrigation flows, and cause differences in water coverage between upper and lower parts of the field. Recent research, however, has found that crop residue reduces irrigation-induced erosion, as well as erosion caused by raindrop impact, without significantly impending the flow of irrigation water. Also, the use of conservation tillage on irrigated cropland may be beneficial in moisture conservation, reducing the number of irrigations needed and the amount of total water applied.

Reduced Costs and Improved Returns

Economic Benefits. A farmer practicing conservation tillage can be affected economically in both the long run and short run. Reduced soil erosion can, in turn, reduce or eliminate the longrun productivity decline with continued unchecked erosion. This productivity benefit can be sizable where erosion is high relative to the depth of the top soil, and negligible where erosion is low and soils are deep.

In the Twin Falls area of Idaho, for example, conservation tillage reduced irrigation-caused erosion on shallow soils by 60 percent, and produced a 50-year benefit of more than $150 (present value) an acre on slopes over 2 percent.

In the short run, conservation tillage can economically benefit farmers even with short-term yield reductions if total tillage costs are reduced sufficiently. Because fewer passes are made over the field than with conventional tillage, both fuel and labor costs are reduced. Also machinery costs are lower unless conservation tillage, particularly no-till and ridge-till, requires purchase or leasing of expensive new machinery before conventional tillage equipment is worn out. Medium-to-large acreage operations can achieve cost reductions because of more efficient machine use. Farmers, including those with smaller acreages who have tillage done on a custom hire basis, may increasingly find conservation tillage less expensive than conventional.

The practice also reduces the time required to complete tillage and planting operations. This may be critical in achieving successful double cropping or in getting single season crops seeded quickly to gain additional growing days.

Some cost items may initially go up. Some first-time users increase pesticide use because of concern over potential increased weed and insect problems. As experience is gained, pesticides are generally not used more than with conventional tillage, and may be less.

Impact on Crop Yield. The impact of conservation tillage on current crop yields depends heavily on soil type, soil temperature, soil moisture, and the type of conservation tillage used. The higher residue cover provided by conservation tillage helps conserve soil moisture, which in dryer climates may actually increase yields. The cover may help protect soils from cold during the winter and give fall-seeded crops an additional edge come spring.

Where soils are cold and wet, however, no-till and mulch-till could retard soil drying and warming in the spring, delaying seeding or plant growth and potentially lowering crop yields. In the Corn Belt, for example, about one-half the cropland is suitable for no-till and two-thirds for mulch-till. However, ridge-till is an acceptable conservation tillage practice on cold wet soils and is increasing in popularity partly because of its adaptability over a wide range of soil conditions.

Some type of conservation tillage is usually adaptable to most soil and climate conditions. When not adapted, or when the best type of conservation tillage cannot be used because of machinery limitations or personal preferences, crop yields may be reduced. In this case a profit-maximizing farmer would have to compare the value of the reduced yield against the tillage cost savings and long-term productivity benefits. Conservation tillage could still be the best decision.

Environmental Impacts

By reducing erosion and runoff, conservation tillage can significantly reduce sediment and nutrient loadings into streams and lakes.

Some concern exists, however, about the effects of widespread use of conservation tillage on ground-water quality. Because the practice increases water infiltration, and some farmers increase pesticide use, the potential exists for greater movement of pesticides and nitrogen into ground water. Monitoring for potential ground-water contamination in vulnerable areas is increasing as well as research and extension efforts on pesticide and fertilizer management for different areas and tillage situations.

Trends

In addition to increased use of conservation tillage, acreages in no-till and ridge-till have been expanding more rapidly percentagewise than acreages in other types. In 1986, no-till was used on 14 million acres of U.S. planted cropland, an increase of 43 percent from 1983. Ridge-till use on 2 million acres of planted cropland was nearly double its use in 1983. In contrast, acres in mulch-till and reduced-till together increased about 9 percent over 1983.

While some people see use of conservation tillage increasing to 60 percent or more of total cropland within 25 years, factors likely to influence the practice's expansion are mixed. On the positive side are farmers' desire to reduce production costs and increase returns, public interest in cleaner streams and lakes, conservation compliance requirements of 1985 farm bill legislation, and continued technology improvements making the practice better adapted to more areas.

Factors possibly dampening expansion are lower fuel prices that have reduced the cost savings of the practice, and the farm credit crunch and low farm product prices that have stopped many farmers from purchasing new machinery designed for conservation tillage and from making innovations in production methods.

What Prompted the Nation's Conscience About Its Forests?

Harold K. Steen, executive director,
Forest History Society, Inc.,
Durham, NC

From the time that the Continental Congress passed the Land Ordinance of 1785 to the latter decades of the 19th century, public lands were officially seen as being either suitable or unsuitable for agriculture. Other logical categories of land received little attention.

Concern Over Abandoned Land

This intense focus on farms and farming was not all that misplaced, for until midcentury, most land clearance was at the hands of farmer/settlers; trees felled in the process were then available for the stove or the saw. The rise of the lumber industry with its great appetite for timber, however, meant that land could be, and was, cleared far in excess of agricultural needs. It was these cutover and often abandoned lands that prompted concern; in retrospect, this concern was the beginning of the conservation movement.

Early Signals

In 1864, George Perkins Marsh published his seminal *Man and Nature: or, Physical Geography as Modified by Human Action*. Marsh, a linguist, wrote of damage wrought by unwise logging throughout Europe; his impressive work is quoted even today. The following year Reverend Frederick Starr wrote with alarm about U.S. forest destruction; his article was included in the annual report of the Commissioner of Agriculture. And in 1875, Dr. John Aston Warder founded the American Forestry Association, the first citizens' forest conservation group in America.

Another physician, Dr. Franklin B. Hough, was largely responsible for prompting initial Federal involvement in forestry. Hough was also a statistician who compiled reports for the U.S. Census. A native of Lowville, New York, he saw that from one census to the next, sawmills in New York disappeared in the eastern part of the State, while new ones cropped up farther west. He saw the link between exhausted timber supplies and sawmill closures, and presented a paper at the 1873 annual meeting of the American Association for the Advance of Science.

Hough's "On the Duty of Governments in the Preservation of Forests" so impressed his scientific audience that the association passed a resolution calling for Federal action. He lobbied in Washington, DC for 3 years, and in 1876 Congress placed a $2,000 rider on the agricultural appropriations bill for a "timber agent." Justifiably, Hough received the appointment, and became the first head of the forestry activity that would slowly evolve over three decades into the USDA Forest Service.

Taking Inventory

Through voluminous correspondence and research at the Library of Congress, Hough assembled a massive *Report Upon Forestry* in 1877, and Congress authorized the printing of 25,000 copies. He compiled two more reports in 1880 and 1882. The three volumes codified the forestry knowledge of the western world, assembled statistics on forest-related commerce, and recommended courses of action to stem forest devastation.

In a fourth volume in 1884, Nathaniel Egleston's name appeared on the title page, but it was Franklin B. Hough who founded and nurtured this embryonic effort. In recognition, the Division of Forestry was established in 1881 with Hough as chief, instead of merely "forestry agent." Five years later, Congress gave the division permanent status.

Forestry Research

German-born and-trained forester Bernhard Eduard Fernow was appointed chief of the Division of Forestry in 1886, bringing forestry professionalism to the position. Fernow emphasized research, for without solid information on tree growth and wood properties, appropriate administrative policies would be difficult to formulate. The scientific products of the Division of Forestry during Fernow's 12-year tenure as chief were very impressive. Unfortunately his great concern over status within the department led to much bickering and limited his administrative effectiveness. He did outline a structure for a decentralized forestry agency, however, that served as a model for his successors to follow.

To Set Aside Forest Reserves

In addition to his Division of Forestry responsibilities, Fernow served as secretary to the American Forestry Association (AFA), an institution that was growing in influence. AFA and Fernow were involved as Congress in 1891 codified myriad public land laws, hastily adding a section that authorized the president from "time to time" to set aside forest reserves. This grabbag law contained no provision to manage such reserves, and it was 6 years until Congress—amid great controversy—approved a rider to the general appropriations bill that established basic purposes for forest reserves.

Since the primary thrust of neither act had nothing to do with forests, only with the benefit of hindsight have forestry names been attached to

Forest Service Chief Gifford Pinchot, under Presidents William McKinley and Theodore Roosevelt, made innovative and far-reaching policies for the use and management of National Forests. (FS)

them: the Forest Reserve Act of 1891 and the Forest Management Act of 1897 In 1907 the forest reserves were renamed National Forests, and in 1973 the Forest Management Act of 1897 was central to an all-important lawsuit. The Forest and Rangeland Renewable Natural Resources Planning Act of 1974 (RPA) and the National Forest Management Act of 1976 (NFMA) grew out of this suit.

Becoming a Priority

James Wilson became secretary of agriculture in 1897, Fernow's last full year as chief of the Division of Forestry. Wilson served for 16 years until 1913, the longest incumbency of any Cabinet member. Under his leadership, the department became the leading agricultural research establishment in the world. The Division of Forestry with its scientific focus fit well within Wilson's priorities, and in 1901 he elevated it and other divisions to bureau status.

Secretary Wilson appointed Gifford Pinchot to succeed Fernow in 1898. Following graduation from Yale, Pinchot studied forestry in Europe for a year, returning to America in 1890 to begin an illustrious forestry career. He served briefly as Fernow's assistant but then became a forestry consultant.

A major client was George Vanderbilt, who asked Pinchot to develop a management plan for his huge estate in North Carolina. He was appointed to a National Academy of Sciences committee to study the Federal forest reserves, and he served as confidential forestry agent in the Department of the Interior, which had custody of the reserves. Accepting Secretary Wilson's appointment, Pinchot brought forestry skills, energy, and great administrative talent to the small Division of Forestry.

Growing National Support

Wilson offered Pinchot a free hand, and he spent a large part of the next 7 years convincing Congress to transfer the forest reserves from the Department of the Interior to the Department of Agriculture and his Division of Forestry. He also worked effectively to develop agency infrastructure and cooperative forestry programs with private landowners and the General Land Office, which still had jurisdiction for the forest reserves.

President William McKinley was assassinated in 1901, and Vice President Theodore Roosevelt was sworn in as his successor. The new president was a vigorous man and placed great importance on natural resources. He was a hunting enthusiast and was a cofounder of the Boone and Crockett Club. He also believed in an aggressive executive, one who did not wait for legislative initiatives. His interests and temperament combined in support of Pinchot's programs.

Pinchot and Roosevelt were already acquainted from his days as New York governor; now Pinchot moved to take advantage of presidential support for transferring the reserves. The American Forestry Association and other citizen groups favored this action, and even the secretary of the interior, who presumably would defend his domain, fell into line. But key members of Congress were harder to convince. It was not until March 1, 1905 that 67 million acres of reserves were transferred and the agency was renamed "Forest Service." With strong presidential support, within 2 years the reserves—now National Forests—included 150 million acres.

Forest Service Creed

Pinchot quickly wrote a letter of instructions to himself for Secretary Wilson's signature. The letter became the Forest Service creed; the National Forests were to be *used* and management decisions were to be made upon local grounds, reinforcing the already strong impulse for decentralization. The most often quoted phrase in this seminal letter ended a sentence giving priority to the dominant industry; "conflicting interests must be reconciled. . .from the standpoint of the greatest good of the greatest number in the long run."

With Roosevelt's leadership assured, Pinchot developed an effective coalition of politicians, scientists, and conservationists, especially those interested in water resources such as Frederick H. Newell, first director of the Reclamation Service, and Francis G. Newlands, who sponsored the 1902

Reclamation Act. Although in some respects concepts of reclamation and conservation are in opposition, the cooperative efforts attracted western support for reclamation and eastern support for conservation—jointly, there were enough congressional votes to achieve essential legislation.

Building the System

Pinchot was a skilled administrator, who attracted a talented and extraordinarily loyal staff, and he delegated authority freely. He innovated filing and budget systems that were adopted governmentwide, and he cultivated grassroots support for his agency through an extensive public information program. His vigorous initiatives included calculated risks, as he developed a lengthy list of administrative and legal precedents that would stand the test of time. The legal right for the Forest Service to issue regulations to manage the myriad resources on National Forests and the right to collect user fees from stockmen and others are examples of his many achievements.

Pinchot moved on many fronts. He strengthened control of grazing through use of highly qualified personnel and acquiring the respect of stockmen. Although a staunch advocate of "practical" forestry, he also threw his support behind forestry research, including the establishment of the Forest Products Laboratory in Madison, Wisconsin. Private timber supplies being generally ample, timber management emphasized demonstration silviculture to show what practices were possible. Too, he had formal association with the 1903 Public Lands Commission, the 1905 Forestry Congress, the 1907 Inland Waterways Commission, the 1908 White House Governors Conservation Conference, and the 1909 National Conservation Commission.

End of an Era

Roosevelt left the White House in 1909, and his successor, William Howard Taft, favored a more traditional management style that included a well-defined chain of command. Thus, Pinchot lost his generally free hand in natural resources matters, explaining in part why he elected to force his own firing by committing an act of gross insubordination. When he publicly accused Secretary of the Interior Richard A. Ballinger of misdealings associated with Alaskan land claims—a bureau chief attacked a member of the Cabinet—President Taft dismissed him in January 1910. The ensuing congressional investigation captured headlines for the next several months. The Republican-controlled Congress supported Taft, but significant political damage had been done, and some of the zeal had gone out of Pinchot's conservation movement. Much more would be accomplished subsequently, of course, but never again would a single figure be so dominant.

Soil Conservation Is an Old-Time Religion

Douglas Helms,
historian, Soil Conservation Service

A Tennessee hillside, too steep for row crops, is seeded to tall fescue grass in contour rows. (H.C. Green, SCS, TENN-D67-1)

The idea that Americans should conserve soil to maintain the Nation's capacity to produce food is neither new nor outdated. Some colonial Americans knew the dangers of exhausting the land and undertook conservation measures even then. Some of the earliest conservationists increased fertility and lessened erosion by maintaining ground cover, improving soil tilth, and instituting pasture, legume, and crop rotation systems.

Though he invented neither, Thomas Mann Randolph, Thomas Jefferson's son-in-law, quickly perceived the advantages of the hillside plow and horizontal, or contour, plowing. As a convert to the idea, Jefferson believed that "In point of beauty nothing can exceed that of the waving lines and rows winding along the face of the hills and valleys."

Nicholas Sorsby combined horizontal farming with the early progenitor

Hugh Hammond Bennett, first chief of the Soil Conservation Service, loved to carry the message of soil conservation to rural America. Here, he speaks on a Kentucky farm in 1948. (Soil Conservation Society of America)

A Civilian Conservation Corps enrollee sets out pine seedlings in South Carolina in 1941, helping reforest land not suited to cropland. (SCS, SC-10,392) of the terrace—the hillside ditch—and greatly popularized"level culture" throughout the South.

The most outstanding of the pre-Civil War agricultural reformers, Edmund Ruffin, experimented to learn the effects of green manures and liming on soil conservation and soil fertility. After the Civil War, Priestly Mangum of Wake Forest, North Carolina, perfected the broadbased Mangum terrace for managing surface runoff.

Few agriculturalists viewed soil conservation as vital in the public agricultural institutions created in the latter half of the 19th century. These were the U.S. Department of Agriculture (USDA), the land-grant colleges, and the State agricultural experiment stations. USDA and the State experiment stations and Extension Services did publish bulletins on the subject. Eventually, two State experiment stations, those at Columbia, Missouri and Spur, Texas, concentrated on soil erosion.

Hugh Hammond Bennett, who led the soil conservation movement in the 20th century, first called for research. Largely at his prodding, the USDA appropriation act for 1929 included provisions for soil erosion and moisture conservation research stations. Bennett's first assistant at the Soil Erosion Service, Walter Lowdermilk, made seminal discoveries in the relationship of forest litter to runoff.

Education

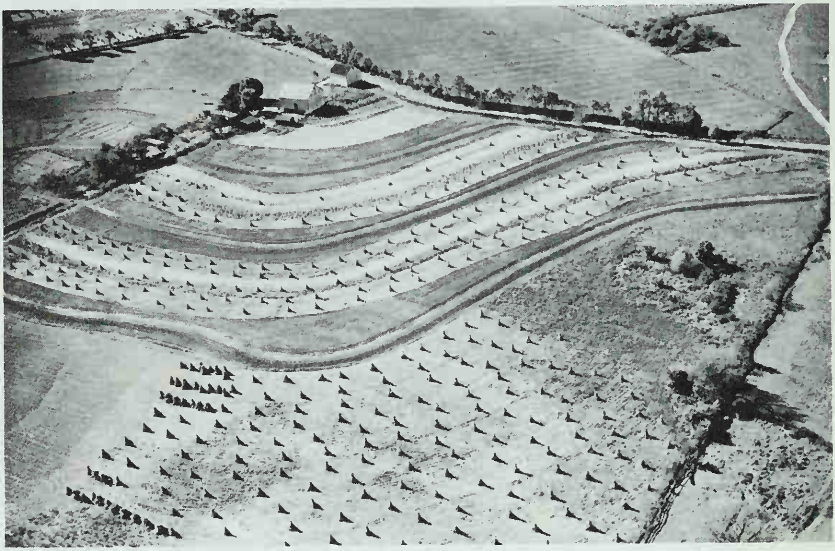
When Hugh Hammond Bennett began his crusade for soil conservation as a soil scientist in the USDA, he proposed to use demonstration methods so that farmers would observe proven methods of soil conservation, then go forth and do likewise. He located the earliest demonstration projects near the erosion and moisture conservation experiment stations, where the results of the research could be put to use.

The Soil Conservation Act of 1935 enabled Assistant Secretary of Agriculture Milburn L. Wilson to make conservation expertise more readily available to farmers through soil conservation districts. This provided for local participation in planning operations and attracted political support from farmers. On February 27, 1937, President Franklin D. Roosevelt transmitted the "Standard State Conservation Districts Law" to the governors. Each State then enabled local people to organize districts and elect supervisors. The districts then signed agreements with USDA.

Trained USDA soil conservationists work directly with farmers in the nearly 3,000 conservation districts. The districts or States sometimes provide additional personnel.

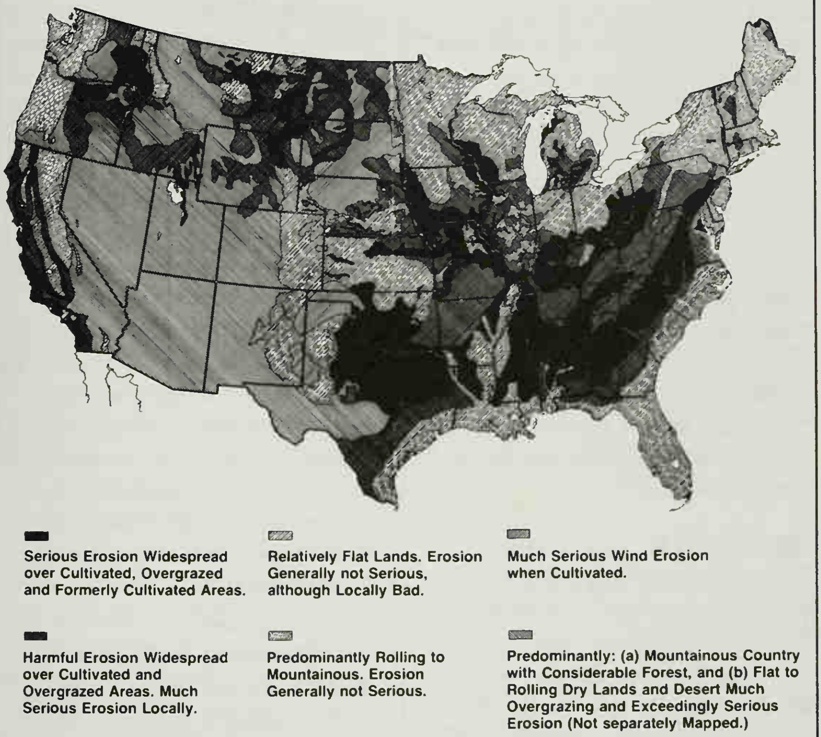
Sharing the Costs

Sharing the cost of conservation became a major part of agricultural programs with the passage of the Soil Conservation and Domestic Allotment Act in 1936. Spending public money on soil conservation is premised on society's having an interest in preventing erosion. It is viewed not only as a matter of equity, but also as an inducement for farmers to practice



A system of terraces and stripcropping, in which alternate bands of close growing and clean tilled crops were planted on the contour, reduced erosion on this Pennsylvania farm. (Lowary, SCS, PA-40592-B)

An Arkansas farmer, using mules and a fresno, constructs a terrace to channel rainfall off his cropland. (SCS, ARK-D5-2G)



General Distribution of Erosion

Serious Erosion Widespread over Cultivated, Overgrazed and Formerly Cultivated Areas.
Relatively Flat Lands. Erosion Generally not Serious, although Locally Bad.
Much Serious Wind Erosion when Cultivated.
Harmful Erosion Widespread over Cultivated and Overgrazed Areas. Much Serious Erosion Locally.
Predominantly Rolling to Mountainous. Erosion Generally not Serious.
Predominantly: (a) Mountainous Country with Considerable Forest, and (b) Flat to Rolling Dry Lands and Desert Much Overgrazing and Exceedingly Serious Erosion (Not separately Mapped.)

conservation. In early demonstration projects, SCS provided Civilian Conservation Corps enrollees or Work Projects Administration laborers. Additionally, SCS provided seed, seedlings, lime, and fertilizer to help farmers to establish pastures, restore gullied areas, and work hay crops into crop rotations, and helped to build terraces and fencing, and improve woodland.

Land Use Conversion Programs

Converting very erodible cropland to forests or grasslands has had a great appeal to people concerned about soil erosion. Frequently called "land retirement" programs, these programs generally had as a goal not retirement, but conversion of land to another use. Congress and USDA often had objectives in addition to soil conservation when instituting such programs.

The current cropland reduction effort, the Conservation Reserve Program authorized by the 1985 farm bill, limits the program to "highly erodible" land. Crop surpluses again gave impetus to paying farmers to convert cropland to other uses. But other forces caused eligibility to be limited to erosion-prone land. Understanding of the erosion processes has increased, enabling conservationists to estimate sensitivity to erosion damage, and progress in making soil surveys made it possible to identify highly erodible land. Then too, a coalition of environmental groups influenced Congress to restrict the conservation reserve to the most erodible land. In addition to their long-standing emphasis on wetlands, wildlife interests now focus on cropland conversion as a means of increasing the variety and distribution of upland wildlife.

Profitability

The profitability of conserving topsoil appeared to be a much simpler question before benefits of scientific agriculture became available. Effective use of fertilizers clouds the perception that expenditures for conservation will be captured in the farmer's lifetime.

Costs of erosion are not limited to the lost productivity; costs away from the field, or offsite, also should be counted. Sedimentation specialists in the 1930's studied siltation reservoirs in order to understand erosional processes; their studies also illuminated the offsite costs.

Stewardship

According to some sources, Patrick Henry proclaimed shortly after the American Revolution, "since the achievement of our independence, he is the greatest patriot who stops the most gullies." The sentiment that conservation should be viewed not only as a matter of self-interest, but as an obligation, had, and continues to have many forms of expression. Certainly, a dispassionate case can be made for soil conservation, but like many another movement that came to be enacted into a national program by Congress, it involved emotions.

Soil conservation as a religious duty found expression in "Soil Stewardship Week." *Farm and Ranch* magazine sponsored a "Soil and Soul Sunday" from 1946 until 1954. The National Association of Conservation Districts assumed responsibility in 1955 and elicits support from many denominations.

An Enduring Agriculture

When a national soil conservation program began in the 1930's, the young group of conservationists attacked their job with enthusiasm. Being optimists, and no better seers than we are today, they perhaps were unmindful of how a dynamic agriculture could undermine some of their good works. But they did establish an objective by which to judge various conservation methods—an enduring agriculture. Enduring did not imply a static agriculture, but it held that the means to sustain agriculture, the physical integrity of the soil resource, must be maintained.

What Price Conservation and Who's Paying?

Liu-Hsiung Chuang, agricultural economist, Evaluation and Analysis Division; Roy M. Gray, special assistant to chief for legislative affairs, Soil Conservation Service; James R. McMullen, director, Conservation and Environmental Protection Division; and Otis N. Thompson, chief, Field Service Branch, Information Division, Agricultural Stabilization and Conservation Service

Soil conservation districts were authorized by the Standard State Soil Conservation Districts Laws in 1937. Today there are 2,934 conservation districts in the Nation. Together with the Agricultural Stabilization and Conservation Service (ASCS) county committees as well as other State and local agencies, they play a key role in delivering technical and financial assistance to land users. The conservation districts are responsible for setting priorities and directing conservation work at the local level. The joint Federal, State, local, and private partnership has been the motivating power in the progress of the soil and water conservation movement.

Federal Funding

The Soil Conservation Service (SCS), principal agency in the U.S. Department of Agriculture (USDA) to deal with soil and water conservation, receives annual congressional appropriations, but State and local governments, private organizations, and land users also contribute significantly to the Nation's conservation work.

USDA Funding

Appropriated funds (expressed in 1982 dollars)[1] for SCS operations, which mainly pay for technical assistance to land users, averaged $275 million annually for the past 50 years. Funds for flood control and prevention activities, mainly for small watershed measures, averaged $157 million annually. Overall, SCS funding averaged $465 million annually. The overall SCS funding for conservation activities peaked at $832 million in 1978, then gradually declined to $575 million in 1985.

The amount spent annually through ASCS conservation programs averaged $247 million in the 1980's. The ASCS Soil and Water Conservation Program expenditures declined from $2,038 million annually in 1944 to $168 million annually in 1985.

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[1] All budget figures in this article were calculated in terms of 1982 dollars to facilitate comparisons.

States, Local Government, and Other Funding

State, local government, and organization contributions averaged $269 million a year and have been increasing since 1963. Since 1973, the local share has risen faster than the State and private contributions. In 1985, some 46 States had completed multiyear long-range conservation plans. Today all the States appropriate funds specifically for conservation.

Land Users' Share

The land users' share of conservation costs ranged between 40 to 53 percent throughout the past 50 years with their peak investment taking place in the late 1940's.

USDA Contributions

Funding for technical assistance has remained relatively stable since 1969. Direct cost sharing, however, declined by 77 percent between 1969 and 1985. Funds for watershed construction and conservation practice installations also declined. Emergency program funding and loans fluctuated widely. Program support increased up to 1979 and then gradually declined.

Research and technology investment (without including the resources from the Extension Service, the Agricultural Research Service (ARS), and the Cooperative State Research Service (CSRS) was stable. Resources allocated by Extension, ARS, and CSRS for conservation education, research, and technology amounted to 9 percent of the total USDA conservation contribution in 1982, the most recent year for which figures are available.

The total annual Federal conservation funding through USDA agencies has fluctuated between 0.9 and 1.7 billion dollars since 1969, with a declining trend beginning in the late 1970's.

Total U.S. Commitment

USDA funding represents the largest allocation for conservation while contributions by State, local, and other organizations, though averaging about $267 million a year, have been increasing since 1963 and averaged close to $300 million annually in the 1980's. The gross private share in investment in conservation capital has declined since the peak of 1946-50 to about $482 million in the 1980's. The annual total resources invested in soil and water conservation ranged between $1.5 billion and $2.5 billion between 1969-85, about 0.8 to 0.5 percent of the total U.S. Federal expenditure.

Achievements

The last National Resources Inventory (NRI) in 1982 shows that 55 percent of cropland, 47 percent of pastureland, 64 percent of rangeland, 15 percent of forest land, and 7 percent of other land, benefit from conservation practices. Nationwide, 44 percent of non-Federal rural land has conservation practices installed on it. Land areas protected annually by new conservation practices exceeded 54.6 million acres in 1985.[2]

A total of 649 small watershed projects have been completed since 1954, and 417 are under construction. About 20.6 million acres have been protected with structures for sedimentation, pollution abatement, or flood control.

Some 2.6 million water impoundment reservoirs were constructed to reduce erosion, improve grazing management, conserve vegetative cover and wildlife and provide fire protection over the past 50 years. Terraces were constructed on 39 million acres of cropland to reduce erosion, conserve water, or prevent or abate pollution. Stripcropping systems were established on nearly 116 million acres of cropland to reduce water or wind erosion or to prevent pollution.

Mission Incomplete

Soil and water conservation investment has adequately protected about 38.8 percent of non-Federal rural land since the soil conservation program began. Another 57.2 percent of the non-Federal rural land still needs conservation for erosion control, drainage, irrigation management, and improvement or establishment of vegetative cover. It is not feasible to apply conservation practices on about 4 percent of the land, such as quarries.

Because of the declining annual gross Federal investment and private investment in the conservation effort, the total annual investment in soil and water conservation has declined significantly. Coupled with the increasing rate of depreciation on installed measures and practices, the net annual investment rate in conservation has been negative since the late 1950's. Although recent investments are being made in new technologies such as conservation tillage and the increased efficiency may be somewhat offsetting, greater national commitment in conservation investment is still needed to maintain what has been achieved over the past 50 years.

Today's Focus

Since 1981, SCS has been investing more resources to treat highly erodible land in the United States. The Food Security Act of 1985 further defined and expanded that policy. Its subtitle on conservation authorizes the Secretary to conserve and improve the soil and water resources through the reduction of agricultural commodities production on highly erodible land with the implementation of the four key measures: a "conservation reserve" to retire highly erodible cultivated cropland; a "conservation compliance" program to discourage cultivating highly erodible farmland without installing acceptable conservation practices; a "sodbuster" provision to discourage plowing additional highly erodible land without acceptable conservation measures; and a "swampbuster" provision to discourage wetland conversion for commodity production.

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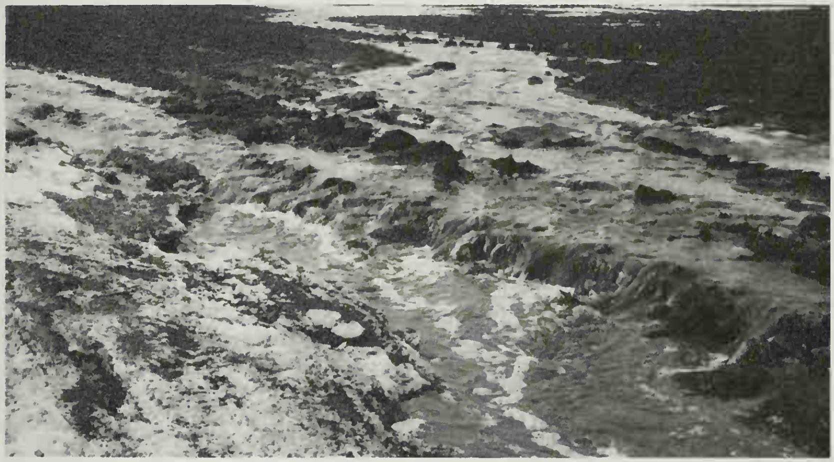
[2] U.S. Department of Agriculture, *Agricultural Statistics, 1986*, Washington, U.S. Govt. Print. Off., 1986.

Today, the U.S. farm economy makes the land users' investment for soil and water conservation even more difficult. The time has come again for the joint partnership of public agencies and private land users to act on conservation.

How To Slow a 175-Tons-a-Second Landslide

Douglas A. Christensen, agricultural economist,
Soil Conservation Service, and Marc O. Ribaudo,
agricultural economist, Economic Research Service



Spring runoff on a plowed field in Wisconsin carries away precious topsoil along with nutrients and pesticides. (F.M. Stone, SCS, WIS-1501)

Every second 175 tons of soil are eroded from U.S. non-Federal lands. Approximately 5.5 billion tons of soil erodes from U.S. non-Federal lands each year with two-thirds of this erosion coming from agricultural land, primarily cropland. Water erosion accounts for 65 percent and wind erosion for 35 percent

What Is Water Erosion?

The process begins with a single raindrop. The force of rainfall detaches soil particles. As rainfall intensifies, the soil surface becomes saturated, causing runoff of excess water, detached soil, and nutrients and pesticides that have adhered to the soil particles.

The type of soil and vegetative cover influence the rate of erosion as does the length and steepness of slope. Sometimes soil travels just a few inches—at other times to the bottom of the hillside. Over time, soil can travel hundreds of miles down-

A Montana field with no protection from wind erosion literally blows away. (Merle B. Brunsvoid, SCS, Mont-183)

There once was a reservoir in the center of this area. Land adjacent to the reservoir was converted from pasture to row crops, and within 5 years the structure completely silted in. (Tim McCabe, SCS, IA-2873) stream from its site of detachment.

What Is Wind Erosion?

Wind erosion occurs when the force of the wind on dry soil overcomes its gravitational pull. This happens when the wind is blowing at approximately 13 miles per hour or more measured 1 foot about the soil surface. Detachment depends on many factors including soil type, roughness of the soil surface, wind speed, and vegetative cover. As with water erosion, transport of windblown soil, with its attached nutrients and pesticides, can occur over long distances and affect the environment far from the original detachment site. The potential for wind erosion is largely due to the tremendous soil-carrying capacity of the air. For example, the air above the Mississippi River basin has been estimated to contain 1,000 times the soil-carrying capacity of the river itself.[1]

Where Does the Soil Go?

When soil particles are being transported, their size and weight are factors in determining where eroded soil and accompanying agricultural chemicals end up. Larger, heavier particles tend to travel closer to the ground in the case of wind erosion, and settle out quicker in the case of water erosion. Smaller, lighter particles, however, will travel farther distances as they are more easily lifted into the air or suspended in water.

If effects of erosion are considered offsite when they leave a field, then the first places for deposition of soil particles are fence lines and roadside ditches and culverts. Windblown soil also may enter farmhouses and other agricultural facilities.

Later, soil reaches creeks, streams, lakes, towns, and cities. Eventually, some soil particles end up in larger rivers and lakes and finally the oceans. Soil, nutrients, and pesticides eroded by water in Iowa or Minnesota can end up in the Mississippi Delta. Erosion by wind in the Great Plains can affect the Great Lakes or East Coast.

What Harm Is Done?

Water Erosion Damages. Runoff water can contain pollutants such as sediment, nutrients, and pesticides. Each of these can limit the ways in which the water can be used safely. Sediment fills reservoirs, blocks navigation channels, interferes with water conveyance systems, affects aquatic life, and degrades recreation resources. Nutrients from chemical fertilizer and manure promote the premature aging of lakes and estuaries and affect recreation, municipal and industrial water supplies, and commercial fishing. Pesticides affect aquatic plant and animal life, reduce recreation opportunities, and possibly endanger human health.

Wind Erosion Damages. Windblown soil and accompanying pollutants can cause a variety of damages to households, businesses, public services, and the environment.

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[1] R. Neil Sampson, *Farmland or Wasteland*, Emmaus, Pa., Rodale Press, 1981, 422 p.

Annual Costs of Water Erosion

Category	Damage ($ million)	Regions Most Affected
Freshwater recreation	1,889	Corn Belt, Northeast, Pacific
Marine fishing	544	Pacific, Northeast
Water storage facilities	1,097	Mountain, Pacific
Navigation	680	Delta States
Commercial fisheries	409	Pacific, Northeast
Flood damage	888	Pacific, Delta States
Drainage ditches	214	Corn Belt, Northern Plains
Irrigation systems	107	Pacific, Mountain
Water use and treatment	1,231	Northeast, Appalachian, Lake States
Salinity	28	Mountain, Pacific
Biological	No Estimate	
Total	7,087	Pacific, Northeast, Corn Belt

Sources: Economic Research Service and Conservation Foundation

Drifting soil destroys fences, fills water conveyance facilities, and causes traffic and health hazards. Blowing soil also causes damages to buildings, machinery, and wildlife. In addition, smaller soil particles, those most subject to wind erosion, have a large total surface area which allows more nutrients and pesticides to adhere to them. Windblown particles contain twice the nutrient concentration as their parent material. Therefore, the detrimental effects of windblown soil on water quality are intensified as the ''nutrified'' particles settle into our Nation's waterways.

How Much Does It Cost Us?

Water Erosion. Here are a few estimates of the offsite costs of soil erosion.

Damages to freshwater recreation, water use and treatment, and water storage facilities account for 60 percent of estimated offsite costs from water induced soil erosion. Regionally, the Corn Belt, Pacific, and Northeast States suffer nearly one half the damages. Total damages are estimated at $7 billion per year, (excluding biological impacts, which while being significant, have not been measured). This translates into an average cost of $120 a year for every family in the country.

Wind Erosion. The offsite effects of wind erosion are even more difficult to measure than offsite effects of water erosion. ERS cost estimates range from $3 to $7 billion a year for the western United States where most wind erosion occurs. These costs do not include long-term health costs caused by dust particles, costs resulting from automobile accidents, long-term costs of damages to exterior surfaces, or impacts on water quality.

The annual offsite costs from wind erosion are an additional $55–$120 for each U.S. family bringing each U.S. family's total offsite erosion cost to $175–$240 annually. For the farm family, these costs are in addition to the onsite erosion losses ranging from lost production to increased production costs.

What Can Be Done?

Offsite effects can be minimized by controlling either the detachment or transport phase of the soil erosion process, and through careful chemical management.

Controlling Detachment of Soil. One way to protect the soil surface from the elements is by growing sod-based crops and crops with a high degree of vegetative cover. A crop with a large proportion of vegetative cover, and thus a large amount of residue, will not protect the soil if that residue is plowed under. Conservation tillage practices that leave residues on the soil surface reduce detachment and therefore control erosion.

Controlling detachment in the range areas of the West involves, among other things, grazing intermittently or rotating livestock from one range to another. These practices allow the grasses to be maintained and maximize soil protection. Range seeding and prescribed burning also help maintain proper stands.

Controlling Transport of Soil. For water erosion, runoff reduction and containment is essential for minimizing offsite costs. Conservation tillage decreases soil loss by slowing water runoff. The surface residues tend to puddle the rainfall, allowing more time for infiltration into the ground. Planting row crops on the contour, rather than up and down the hill, also increases the infiltration period by holding water between the rows.

On steeper slopes, water disposal systems which usually include terraces and grassed waterways or tile, hold runoff water and channel it out of the field with a minimum of erosion. Sediment basins and farm ponds hold runoff water as well, and allow for settling of soil particles, nutrients, and pesticides.

Wind erosion can be reduced by maintaining surface roughness which reduces wind speed at ground level. Conservation tillage accomplishes this with crop residues on the ground. Strip cropping and planting of windbreaks are practices which reduce wind speed, too.

Chemical Management. Applying fertilizer and pesticides only as needed, at times when runoff is minimal, maximizes the positive onsite effects and decreases negative offsite chemical effects. A study by the Iowa Agricultural Experiment Station suggests Iowa farmers could cut their commercial fertilizer usage one-half or more and still maintain yields by using nitrogen-fixing crops like alfalfa and by properly applying animal manure.

This New Jersey coastal plain pond suffered from heavy water-weed growth due to siltation and excessive runoff containing fertilizers. Various governmental agencies combined efforts to improve drainage of the 600 by 1,500 foot pond. (Clarence Deland, SCS, NJ-40,498)

What Will the Future Bring?

Public awareness of the adverse offsite effects of soil erosion is increasing. Research is ongoing at the Federal and State levels to aid farmers in their attempts to control soil erosion. Computer models simulate erosion runoff, predict sediment yields, pinpoint specific areas in need of treatment, and evaluate potential water quality problems. Special equipment and techniques monitor soil erosion including field dust samplers to analyze airborne soil and measuring sediment deposition rates using radioactive Cesium 137, both developed by the Agricultural Research Service.

With the development of more sophistication in monitoring and predicting offsite effects of soil erosion, conservation systems can be used as efficiently as possible on areas that contribute most to offsite damages. Further knowledge and continued implementation of conservation is needed to reduce the offsite costs of erosion, for which we all pay.

Grass—Earth's Healing Bandage

Allan Nation, editor,
Stockman Grass Farmer Magazine,
Jackson, MS

"The general custom has been, first to raise a crop of Indian corn...then a crop of wheat...and so on, alternately, without any dressing, until the land is exhausted, when it is turned out, without being sown with grass seeds, or any other method taken to restore it; and another piece is ruined in the same manner. No more cattle is raised than can be supported by lowland meadows and swamps. ...Our lands were originally very good; but use, and abuse, have made them quite otherwise."...George Washington in 1768.

Thoughtful citizens have continually tried to insert the issue of soil conservation ethics into the American agricultural debate. They point out that one farmer's abuse of the land can affect all of us through the degradation of the watershed and ultimately the Nation's water supply. Often forgotten in the race for higher yields per acre are the underlying basics of soil science.

Grass, Soil's Natural "Glue"

Grass, including legumes, has long been recognized as the premier maintainer of the soil's natural "glue," which prevents wind and water erosion. Heavy tillage, combined with bare soil during the fallow season, has left much of the country's cropland deficient in organic matter, especially in the Southeast and Southwest where hot summers and warm winters accelerate the decline.

Recent research in Georgia has shown a doubling of yields for rowcrops grown after 5 years of sodgrass. Australian research indicates farmers in hot climates need to grow 1 year of grass for each year of crops to maintain a healthy level of soil organic matter, and soybean farmers in Brazil and Argentina are currently adding a grazed winter cover crop of annual ryegrass, which allows them to maintain much higher yield levels than those of soybean farmers in other hot climates.

Unfortunately, in the United States animal and crop agriculture have become "specialized" into separate and frequently antagonistic ownerships. This specialization has not only had an impact on the economic stability of farmers, but also an equally severe impact on the soil. This soil quality decline has frequently been

Cattle are shifted from the paddock they have been grazing to one where the grass has had time to recover. Grazing animals adapt quickly to frequent moves once they realize they always are moved to better pasture. (Stockman Grass Farmer)

masked through the increased use of fertilizers, herbicides, and pesticides. Government programs that pay farmers to semipermanently retire cropland ignore the fact that all cropland needs to be periodically regenerated through a grass rotation. While the esthetic beauty of pastureland is appreciated and its soil healing properties widely known, neither of these have been able to offset the economic pressures felt by today's farmers.

Today, more proponents of agricultural sustainability are realizing that grass, to be considered both a short-term and a long-term solution to a farmer's problem, has to economically compete with crop production. A growing interest in the concept called grass farming has developed.

Grass Farming

Grass farming differs from traditional livestock ranching. Rather than manipulating the environment for the benefit of the animal, as has been traditionally done, the animals are manipulated for the benefit of the grass plant. While this may not sound revolutionary, it has required a mental adjustment for farmers who have long described themselves as cattlemen, sheepmen, or dairymen, instead of grass farmers. It is this shift in management emphasis, however, that is allowing ruminant animal agriculture to economically compete with cropland farming.

Grass Plant Needs Rest. Nature has provided for grazing by allowing surplus root reserves in the grass plant. These provide the energy to regrow the sheared leaves of the plants. As long as the plant receives adequate rest to rebuild these root reserves, there is no lasting damage to the plant from grazing. Grazing and regrazing time is controlled by pasture subdivision. Since grass will attempt to regrow within 3 days of having been grazed, and since it should not be grazed again until it has fully recovered, the animals must be moved in 3 days or less. Overgrazing results more from inadequate rest time for the plant than from the severity of the plant's defoliation through grazing. Grass can be completely defoliated by fire and show no lasting damage as long as the plant has time to recover. The same is true of grazing.

Monitoring Grass Regrowth. By monitoring the grasses' regrowth, suppose it will take approximately 31 days to regrow. By dividing 3 into 31, 11 pasture subdivisions are needed to meet the grasses' needs within a 3-day timeframe.

However, what if the next day a cold snap rolls in and it takes 45 days for the grass to regrow? The minimum number of subdivisions must match the longest regrowth period divided by 3 days or, in this case, 15 subdivisions.

Now what happens when the weather warms up and the grass starts growing faster and is ready for regrazing in 15 days? With 15 subdivisions our cattle can be moved once a day, rather than every 3 days. If the grass is regrowing even faster than 15 days, several subdivisions should be routed to hay, silage, or mowing to allow the maximum number of pasture subdivisions to maintain their peak stage of grass quality.

The key to successful grass farming is the monitoring of the grass regrowth. The grass farmer must be able to adjust grazing and remain flexible. Inflexible, fixed-move, rotational grazing can actually be worse than traditional grazing in that it ignores the rest needs of the grass. By resting all of the plants equally, nature re-establishes an extremely diverse pasture of warm season and cool season grasses, legumes, and forbs. This rest can greatly extend the grazing season. If the grass is not grazed at its correct stage, it will quickly deteriorate into stem and seed heads.

Grass Farming Technology

Grass farmers can now use animals to directly harvest crops as diverse as turnips, corn, peas, millet, alfalfa, and milo. Using pasture subdivision to ration the fall growth of cool season annuals, stocker cattle can be kept at a high rate of gain throughout the winter with no hay or supplemental feed in the Sunbelt. Through heavy concentrations of animals on small acreages for a short time, the sharp hooves of the animals can be used to plant crops and grasses. Spraying grass with mixtures of molasses and water, can entice cattle to clear firebreaks and brush.

In fact, creative grass farmers are learning that almost anything a diesel-burning, iron tractor can do can be done with animals. By eliminating the heavy capital investment in tractors, combines, silos, grain bins, feed wagons, herbicides, pesticides, and hundreds of gallons of diesel fuel, grass farmers can bring down more of the sale price of the animal than traditional farmers have done.

Human creativity and fencing technology are finally creating a type of agriculture that is not only more profitable but also sustainable and regenerative of the soil. This type of farming also could help regenerate our rural economy. It is size neutral and so management intensive that a small acreage farmer may actually have an advantage over a large acreage farmer. While the farmers practicing this technology are in the minority today, their numbers are rapidly growing. The future of American agriculture is being regenerated, literally and figuratively, at its grass roots.

Disturbed Land Needs Reclamation To Live

John A. Oyler, Wendell G. Hassell, and
Donald S. Henry, plant materials specialists,
Soil Conservation Service

PEABODY
COAL CO

Today's surface mining operations use huge shovels for uncovering coal and other natural resources. (John A. Oyler, SCS)

The environmental consequences of surface mining usually are severe if the land is not reclaimed. Plants and animals disappear, soil erosion occurs both from wind and water causing dust clouds and siltation of nearby streams and lakes, frequency and severity of flooding increases, and water quality declines from both increased sediment and high concentrations of chemicals, heavy metals, acids, and salts.

The severity of this progression is influenced by the geological, topographical, hydrological, climatic, and ecological features of the disturbed area, as well as the techniques used in mining, handling of the overburden, and disposal of wastes. Most of these factors differ markedly from region to region.

The total U.S. land area disturbed by surface mining currently exceeds 4 million acres, roughly half of which is the result of coal mining. Sand and gravel mining accounts for nearly 25 percent. The remaining 25 percent includes phosphate, stone, clay, metals, and all other mining operations.

Need for Reclamation

More land has been reclaimed during the past decade than since surface mining began. The first worked coal strip mine began operation in Danville, Illinois, in 1866. Mining companies are increasingly aware of their responsibility to restore the land they mine.

Legislation

The first documented controversy between environmentally concerned citizens and the coal industry developed over surface mining in the late 1930's in Appalachia. Surface mining was unregulated, and thousands of acres of useless land and hundreds of miles of contaminated streams followed mining operations. Several State legislatures enacted laws in response to the public outcry. The intent was to control environmental degradation, while not destroying the coal industry.

State Legislation. In 1939, West Virginia was the first State to pass a strip-mining law, followed by Indiana in 1941, Illinois in 1943, Pennsylvania in 1945, and Ohio in 1947. These laws helped to establish a broad advocacy for natural resource conservation.

Federal Legislation. In the past 15 to 20 years, the environmental protection movement in the United States has led to still more stringent laws affecting mining.

The National Environmental Policy Act of 1969 requires Federal agencies to prepare Environmental Impact Statements for all major actions in order to eliminate or mitigate adverse effects. The Clean Water Act and the Federal Water Pollution Control Act of 1972 require industrial compliance with air and water quality standards.

The Surface Mining Control and Reclamation Act of 1977 provides protection for important agricultural lands and establishes a program to reclaim abandoned coal-mined land. It called for States to enact and enforce programs to closely regulate the future of surface mining of coal.

Also in the act was the requirement to establish on regraded areas, and other lands affected, native, self-regenerating vegetative cover.

Nearly all States have some laws or regulations regarding surface mining. Many are even more stringent than the 1977 Federal Law.

Early Reclamation Efforts

The focus of early reclamation was on surface-mined land, stripped for coal. The denuded and rough appearance was of primary concern for those who pioneered in the planting of trees in natural forest regions. Trees were planted by hand over the ungraded land where farm equipment could not be used. Early State laws on replanting of mined lands were amended to include regrading the land. Grading and revegetation are still the main reclamation operations, but water pollution control and long-range land-use planning are important, too.

Surface-mined land subsequently regraded is subject to settling and mass movement as well as erosion by wind and water. Fast-growing herbaceous cover followed by tree planting was researched and reported on as early as the mid-1940's by the Soil Conservation Service, Forest Service, and the Agricultural Research Service, all USDA agencies, as well as by some State agricultural experiment stations.

Many of these early herbaceous plantings determined what species of plants could grow and survive on the mine spoils. Little was available then regarding the complex relationships between plants and soils. Nutrient problems, lack of topsoil, microorganisms, moisture-holding capacity, and toxic elements on the mined sites all were areas needing research.

Research efforts in the 1940's and 1950's primarily were on revegetation and soil science. This contributed much toward understanding the complexity of reclamation. Today engineers, landscape architects, soil scientists, agronomists, foresters, ecologists, chemists, hydrologists, economists, and social scientists all contribute skills and knowledge necessary for successful land reclamation.

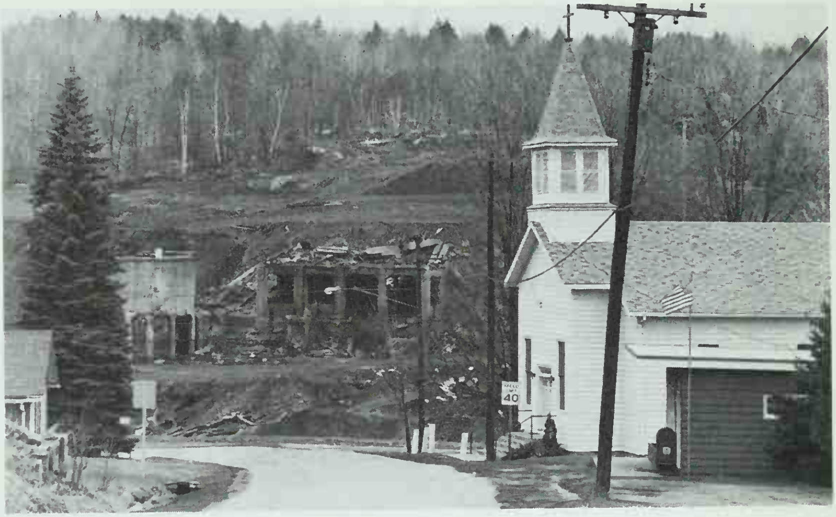
Progress in Reclamation

Large reclamation problems can be avoided with proper premining planning and corrective action taken before, during, or after mining. Premining soil survey data is useful in identifying potential trouble. Soil survey data can help avoid offsite damage as well as aid in plant selection.

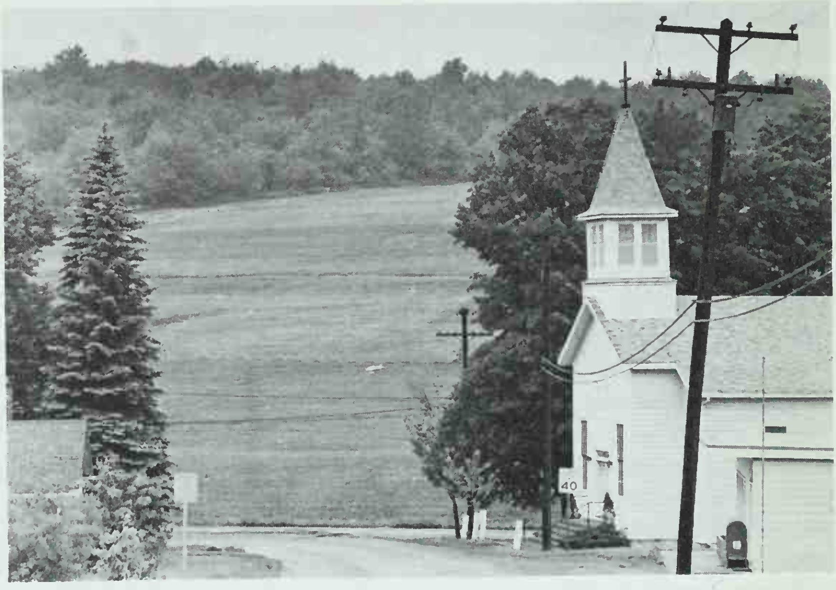
Surrounding natural areas are disturbed as little as possible and topsoil is removed and stockpiled during the mining operation. The topsoil is protected so that it can later be regraded over the mined area to support vegetation. Also, through proper planning, acid-producing or other toxic material exposed during the mining operation can be placed back in the reclaimed area at a depth sufficient to prevent problems.

Conservation Practices. Conservation practices used to reclaim mined sites include diversions, sediment basins, ponds, and tree plantings. Mined sites can be adapted for growing trees with a minimum of grading, and water recreation areas frequently can be included in mined land reclamation plans. Natural waterways and existing vegetation are used wherever possible to divert upstream water away from the mining site. Wooded areas surrounding mining sites are left undisturbed, and more trees are planted to control dust and noise.

Use of Plants. One of the major limiting factors in reclamation work



An abandoned coal mine in Tioga County, PA, was more than an eyesore to passers-by. After a rain, unprotected slopes would erode and tons of soil would wash down to block the road and cause extensive and costly damage to the nearby town. (Tim McCabe, SCS, PA-41,077)



A year later, the area has been transformed through SCS's Rural Abandoned Mine Program. The process involved removing structures, cleaning the area, reshaping the slope, adding topsoil, providing drainage, and seeding and planting the hillside. (Tim McCabe, SCS, PA-41,078) nationwide has been the lack of adapted, commercially available plants, both herbaceous and woody, that can grow, persist, and reproduce in the extreme conditions found on most reclaimed areas. This problem was exacerbated by the 1977 Federal law requiring the use of native plant species to the fullest extent possible.

The Soil Conservation Service operates 24 Plant Materials Centers. These centers systematically collect, evaluate, multiply, and release new varieties of all types of plants that have value in solving conservation problems. Once a new variety is named and released, it is produced by commercial seed producers or nurseries who make the plant available to commercial users. All the Plant Materials Centers have projects underway dealing with some aspects of reclamation of disturbed lands in their respective climatic zones. The centers also develop new techniques for establishing and managing the vegetation on adverse sites.

Since the acceleration of the reclamation movement in the early 1970's, the Plant Materials Centers have released 75 varieties of grasses, 22 varieties of legumes and forbs, and 27 varieties of woody plants. Many of these species are native plants.

Emerging Technologies

Although reclamation work has solved many major problems, newly recognized and severe older problems need to be addressed. As more technology is developed for use on one site, it often can be adapted to other sites.

Acid mine drainage (AMD), for example, has required large, ongoing inputs of revenue to purchase lime, hydroxides, and other neutralizing agents to mitigate acid conditions of water leaving some sites. If the water were to remain acid, it could degrade stream quality. In addition, when the water is acid, soluble compounds of several toxic heavy metals can be present in the water.

The Soil Conservation Service and other groups have recently discovered that the creation of artificial wetlands using certain species of plants can absorb large quantities of these heavy metals, greatly reducing operating costs. Work in Colorado and Pennsylvania has shown that cattails and sphagnum peat bogs can pump out significant amounts of iron. Another plant, horsetail, is capable of assimilating large amounts of manganese. Much work needs to be done yet, but it appears that certain effective ecotypes of these species can be identified.

The future of the reclamation industry looks bright.

FURTHER READING

Schaller, F.W., and P. Sutton, eds., *Reclamation of Drastically Disturbed Lands*, Madison, WI, published by the American Society of Agronomy, the Crop Science Society of America, and the Soil Science Society of America, 1978, 742 p.

Today Wetland Looks Better Than Cropland

Billy M. Teels, national biologist, Soil Conservation Service, and
Terry Cacek, agricultural specialist, U.S. Fish and Wildlife Service

Some 5 percent of the surface area of the 48 contiguous States is wetland, but its productivity is disproportionate to its size and its value, frequently underrated. Pollution control, flood reduction, and habitat for fish and wildlife are wetland values important to everyone. However, farmers and ranchers have used wetlands for irrigation water, grazing lands, livestock water, hay, timber, and crops. Even more valuable to the agricultural community are the drained wetlands that today make up much of the Nation's farmland. Today Americans are looking to halt further depletion of wetlands through effective legislation and wider public awareness.

What's Important Today?

Wetlands are useful environmental filters. Small wetlands perched high in watersheds act as traps for soil sediments to keep them out of rivers and lakes. Excess fertilizers and pesticides that run off the land are also trapped in wetlands where they are broken down chemically or absorbed by wetland vegetation and broken down by biological processes. Water which leaves wetlands, whether to surface streams or underground aquifers, contains fewer chemicals to jeopardize future users.

During heavy storms, wetlands immediately swell as they hold back excessive runoff. They recede slowly—releasing the excess water and reducing the height of downstream floods. Wetlands help water to percolate through soil and ultimately into underground aquifers.

Waterfowl, shorebirds, aquatic mammals, and fish depend on wetlands. The commercial marine fishery, worth $10 billion annually, is largely dependent on species that spawn in coastal wetlands. Equally dependent are sport fishermen who spend $17 billion a year and waterfowl hunters who spend another $638 million on sports made possible by wetland. Upland game birds and small and big game animals use wetland habitat, too.

1800's Wetlands Policy

Federal policy toward wetlands has undergone considerable change. In the 1800's most Americans were farmers and Federal policy was to transfer public lands, including wetlands, to private owners for agricultural development. In the mid-19th century a series of Swamp Land Acts gave 65 million acres of Federal land to 15 States for reclamation. Some of the Nation's best farmland was converted from wetland during that period.

Protecting Waterfowl Habitat

By the turn of the century, however, at least one wetland value, waterfowl habitat, was in jeopardy. Conservationists used the 1916 Migratory Bird Treaty with Great Britain as an opportunity to reconsider the Nation's wetland policies and programs. As a result, laws created and enlarged the National Wildlife Refuge System. Using funds mostly from hunters and other recreational wetland users, the U.S. Fish and Wildlife Service (FWS) began wetland acquisition and to date has acquired control of more than 4.6 million acres of wetland in the contiguous 48 States.

Impact of Water Projects

Twentieth century Federal water projects profoundly affected wetlands. Drainage and flood control projects destroyed wetlands or provided convenient outlets into which individual farmers could drain their wetlands. Searching for a balance between needs for resource development and resource conservation, Congress passed laws requiring that wildlife habitat and other environmental values be considered in the planning of Federal projects.

Foremost were the Fish and Wildlife Coordination Act of 1958, the National Environmental Policy Act of 1969, and the Endangered Species Act of 1973. These acts established requirements to minimize environmental damages, including avoidance of wetland loss and mitigation where wetland was unavoidably damaged as a result of Federal water projects.

United States Army Corps of Engineers

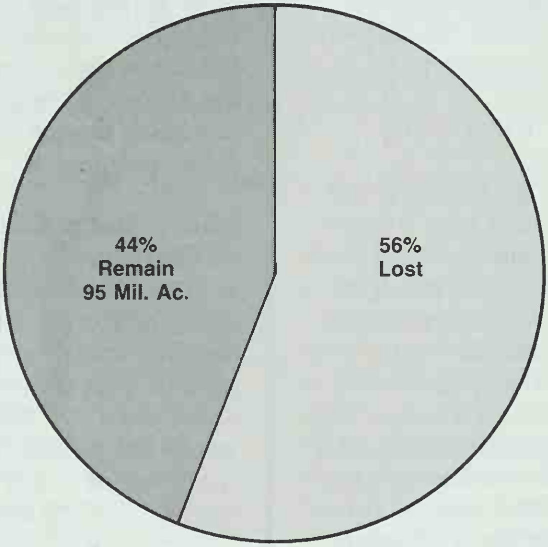
In 1972, Congress expanded the United States Army Corps of Engineers regulatory authority to include wetlands. Corps permits are required for the discharge of dredged or fill material into wetlands. However, most agricultural and forestry activities were exempted by a 1977 amendment.

U.S. Department of Agriculture (USDA)

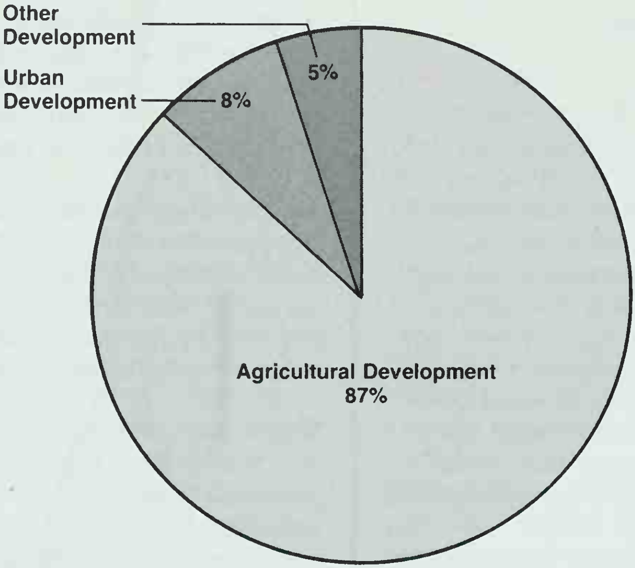
Recognizing the contributions of wetland as well as its endangered status, the Soil Conservation Service (SCS) revised its policy of cost sharing for drainage and creation of wetlands in 1975. It ceased providing technical and financial assistance for drainage of permanent wetlands. In 1977, SCS further restricted its drainage assistance to seasonal wetlands only if they had been cultivated for 3 of the 5 years before the drainage request.

Water Bank Program

In 1979, USDA began a major wetland preservation program with the authorization of the Water Bank Program. Under Water Bank, the Agricultural Stabilization and Conservation



U.S. Wetlands (Lower 48)



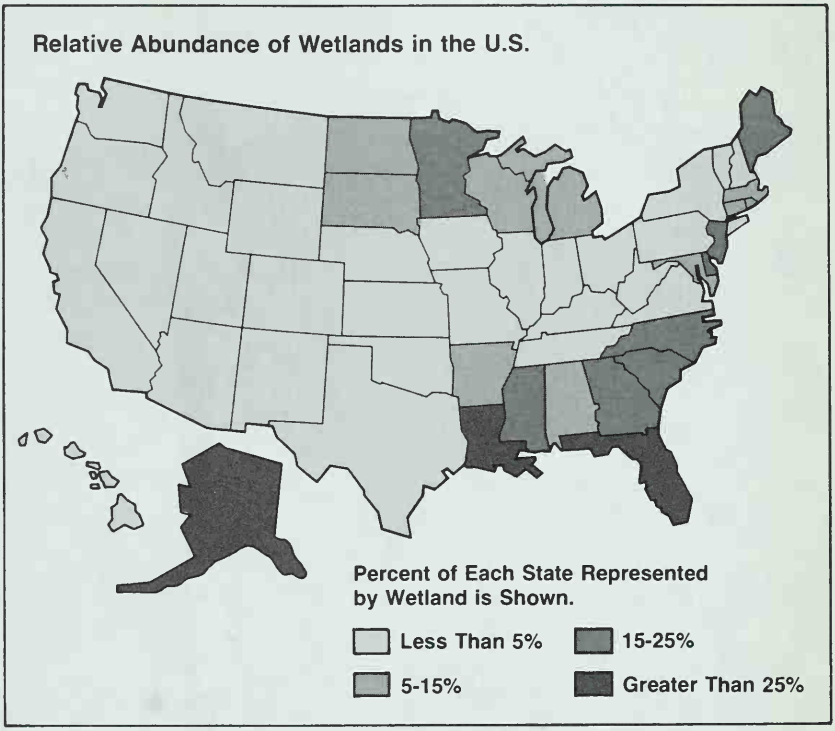
Man-Induced Wetland Losses Mid-50's to Mid-70's

An average loss of more than 450,000 wetland acres a year occurred between 1954 and 1974, with 87 percent of that loss attributed to agriculture. Recent legislation may help reduce wetland losses in the future. (Tim McCabe, SCS)

Service (ASCS) makes annual payments to farmers who preserve their wetlands and maintain wildlife habitat on adjacent uplands. The program is located in the prairie pothole region and in other States that have significant production of breeding waterfowl. Currently 176,209 acres of wetland and 429,768 acres of adjacent upland, located in 13 States, are enrolled in Water Bank.

Classification of Wetlands

In May 1977, Executive Order 11990 was signed into law and it became official policy for all Federal agencies to coordinate efforts to preserve and protect wetlands. The *Classification of Wetlands and Deepwater Habitats of the United States*, published by the FWS in 1979, defines wetlands based on hydrology, hydric soils, and hydrophytic vegetation. This classifica-


Relative Abundance of Wetlands in the U.S.
Percent of Each State Represented by Wetland is Shown.
Less Than 5%
15-25%
5-15%
Greater Than 25%

tion system led to the development of criteria and lists of hydric soils and the plant species that compose hydrophytic vegetation.

Most Federal agencies now use these guidelines in determining what wetlands are. Many State and local governments also have adopted the classification system and used the inventory data in operating their wetlands programs.

Current Status and Trends

Of the 215 million acres of wetlands originally found in the 48 States, 56 percent has been destroyed. Of the remaining 95 million acres, more than one-fourth are currently owned and protected by Federal, local, or tribal governments. Of the 70 million acres in private ownership, more than 5 million acres have been protected by hunting clubs or other conservation organizations such as Ducks Unlimited, the Audubon Society, and the Nature Conservancy.

Despite the combined efforts of government and private programs, wetlands losses between 1954 and 1974 averaged 458,000 acres a year with 87 percent of that wetland converted to agricultural uses. The cost of draining wetlands continued to be offset by the new crops grown on the converted acreage. The goals of wetland protection programs were under-cut by USDA price support programs which enhanced grain prices and provided incentives to drain still more wetlands.

Food Security Act of 1985

This act contains the "swampbuster" provision which largely resolved the contradiction between USDA incentives to drain wetlands and the overall Federal policy to preserve them. Congress declared that any farmer who produces agricultural commodities on newly converted wetland will be ineligible for price support payments and other USDA benefits. Farmers may continue to convert wetlands to crop production but they must use private funds. They cannot use payments received from USDA for wetland conversion, and they must be willing to accept market prices rather than the government-supported prices. Exemptions are granted for conversion begun before passage of the act, December 23, 1985, for conversion of artificially created wetland, for production under natural conditions such as drought, and for conversions that have a minimal effect on wetland.

The "swampbuster" provision was the first national legislation to define wetland based on hydric soils and hydrophytic vegetation—criteria also used in the FWS Wetland Classification System. In the 1985 act, wetland was defined as "land that has a predominance of hydric soils and that is inundated or saturated with surface or ground water at a frequency and duration sufficient to support and under normal circumstances does support a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions."

A Growing Commitment

In addition to the Food Security Act, the mid-1980's brought other laws which strengthened wetland conservation.

The Tax Reform Act of 1985 eliminates the deduction for most drainage expenses and eliminates the capital gains benefit on appreciation of the value of converted wetland.

The Water Resources Development Act of 1986, which authorized new flood control projects, emphasizes the mitigation of wetland losses more than any other previous water bill.

The Emergency Wetlands Resources Act of 1986 refines several wetland protection programs. Most notable are increases in funding for wetland acquisition by FWS.

Why Do Landowners Conserve Soil?

Barbara Osgood, assistant director, Economics and Social
Sciences Division, Soil Conservation Service
and Frank Clearfield, sociologist,
South National Technical Center, Soil
Conservation Service, Fort Worth, TX

The Soil Conservation Service was established by Public Law 46 in 1935 as dust storms blew the country's topsoil from the Midwest to the Capitol Building in Washington, DC. The new Federal agency was to provide technical assistance to farmers, ranchers, and other landowners for installing soil and water conservation practices on their land.

Economics

Because soil and water conservation is voluntary, some farmers and ranchers practice conservation, while others do not. Program planners need to know why before suggesting incentives to encourage participation.

One reason is certainly economics—farmers and ranchers will not use conservation practices if they are too expensive, or if they significantly reduce profits. However, even when conservation practices do not cost money in the long run—and, in fact, may even increase profits—some farmers and ranchers do not practice conservation.

The Conservation Ethic

One factor that affects the voluntary use of conservation is the "conservation ethic." Many land users, especially those who intend to pass farms on to their children, see themselves as stewards of the land obliged to preserve it for future generations. Many rural churches observe annual "Soil Stewardship Sunday" in which these values are reinforced through sermons and special services. Farmers who espouse the conservation ethic will do their best to preserve soil and water resources, even if it means investing some of their own time and money. National surveys show that most Americans believe in conserving natural resources, but experience suggests that this feeling does not always translate into action.

Seeing the Problem

Researchers now believe that many farmers fail to use conservation because they do not perceive a problem on their own land although they may perceive soil erosion problems in their counties or communities. Sheet and rill erosion are more difficult to identify than gully erosion and may account for this attitude. Unless farmers notice silt, they may not

Farmers and ranchers will adopt conservation practices when they perceive that doing so will meet their needs. (SCS)

realize that serious erosion is taking place.

Once farmers and ranchers understand the magnitude of their erosion, they are more likely to turn to conservation practices, especially those that will fit their farming operation.

Farmers are likely to get initial conservation information from farm magazines or other mass media. When they want more detailed information, they go to their friends, to other farmers using the practice in similar circumstances, to government agents, or to agribusiness. Those with higher education and management skills may go beyond county or State offices to seek technical information and assistance. Use of computers in farming today facilitates these information networks.

Seeing the Solution

Information and assistance also are important for farmers and ranchers who decide to adopt resource management systems. Studies on adoption of conservation tillage, for example, show that many farmers believe that they are practicing conservation tillage when they use conservation tillage equipment. When trained technicians examine fields for residue cover, however, they often find that it is far below the criteria for soil protection. Farmers need to know that it is not the equipment they use, but the residue they leave, that constitutes an effective application of conservation tillage.

Practices That Are Adopted

Some conservation practices are more

accepted and more readily adopted than others. Practices that can be tried on a small scale are popular as are those most easily incorporated into the existing operations. Simple, easily understood practices will be more widely adopted than those requiring high levels of management skill. Practices showing visible results are more readily adopted, too, as well as those that are just plain inexpensive.

Community Support

Farmers and ranchers may be reluctant to act contrary to community traditions by practicing soil conservation. This is evident in areas where conservation tillage is considered ''trash farming.'' The community can provide support too through organized educational and informational efforts, public recognition of conservation farmers, financial and technical assistance, equipment loan programs, and peer support groups. Communities frequently benefit from the offsite impacts of soil conservation and may find conservation in their own best interests.

Soil and water conservation programs and activities recognize that all land users are not alike, and that different land users will respond differently to program initiatives.

Delivering Conservation

Technical assistance, financial assistance, and information/education are the three basic components of a conservation delivery system. The professional's first step is to work with local people to identify needs. Then, the conservation delivery system can be modified for specific groups such as limited resource farmers, absentee landowners, corporate farmers, or small family farmers.

Today's Policies

In 1985, the Conservation Title of the Food Security Act of 1985 became law. Many see this as the most significant soil and water conservation action since 1935.

The law requires farmers and ranchers who wish to participate in certain Federal farm programs, such as commodity payments, crop insurance, storage payments, storage loans, and Farmers Home Administration loans, to develop a conservation plan on their highly erodible land by 1990, and implement it by 1995. The decision to adopt conservation practices is no longer entirely voluntary; to participate and receive certain benefits, erosion must be reduced. On the other hand, farmers may choose not to participate and continue to manage their farmland as they wish. The benefits of the USDA programs will have to be weighed against the costs and benefits of conserving highly erodible land. Conservation compliance offers a strong incentive for the land user to decide in favor of conservation—the need to maintain USDA program eligibility.

Coping With Nature

Part VI

Fire—a Natural Force for Land Management

Henry Wright, Horn professor, Department of Range and Wildlife Management, Texas Tech University, Lubbock

Fire caused by lightning has been a part of natural ecosystems since the origin of vegetation on earth. A fire reflects the kind, quantity, and continuity of fuel, fuel moisture, and environmental conditions. Fuels ignited in gentle to rolling topography cause large fires if winds and temperatures are high and relative humidity low. Historically, fire frequencies ranged from 2 to 400 years in most plant communities in North America, their wide range of intensities producing varied vegetative mosaics.

Early Use

Our ancestors discovered fire more than 500,000 years ago, but learned to use it only during the last 20,000 years. The use of fire, along with lightning, intensified fire's effect in many ecosystems, particularly in grasslands and bordering communities where people live year-round. Crops grew well in grasslands and game was easy to harvest on freshly burned areas. Moreover, dead wood, resulting from burns near grasslands, provided an important source of wood for winter fuel.

European Philosophy

Fire continued to have a major impact on North American plant communities after the arrival of Europeans because of how it was intentionally used as well as because of careless use. Fire was seen as an undesirable force because it killed trees. This was understandable because European trees were grown in cultivated systems and protected until harvest time.

18th-19th Century Views

Fire suppression started in earnest about the time of Teddy Roosevelt's presidency. It is ironic that the champion conservationist was poorly informed about the value of fire in resource management. Exclusion of natural fires in grasslands, shrub communities, and forests had no place in North America because these ecosystems evolved with fire.

European forest fire-protection philosophy in North American Forests spilled over into every plant community in North America. Not until the *Leopold Report of 1963* did the public learn that protecting all plant communities from fire could be undesirable. Without fire a number of undesirable things occur: excessive fuel buildups, stagnant young pine trees, dense understories of shrub and trees in forests that could lead to catastro-

Periodic fires allow established trees to mature and new trees to establish as well as allow more diversity in species of trees in Montana. (Henry A. Wright, Texas Tech University)

phic stand-replacing fires; decadent shrub and grassland communities; encroachment of shrubs and trees into grasslands; monocultures of trees that lead to increased disease and insect damage as well as decreased wildlife diversity and, ultimately, uncontrollable fires.

Benefits Today

Use of fire as a management tool began in the southeast and northwest and spread quickly on a limited scale to all of North America. Interest has accelerated in the past 10 years because alternative management tools, such as chemical and mechanical treatments, are environmentally unacceptable, ineffective, or too expensive.

Alternatives to fire have been unsatisfactory in dealing with insect and disease outbreaks in forests. Our western forests have been protected from fire now for 80 years and the negative aspects are showing. So much dead fuel has accumulated in chaparral communities and in the understory of protected forests that wildfires can no longer be controlled. Wildfires are most common during dry years following fuel buildup and can be extensive where fuel loads are high. The leading front of a wildfire generally stops because of natural barriers or a change in weather.

Misconceptions About Fire

Animals. People have a misconception that many animals are killed by fires. The principal way that fires affect densities of animals is by altering habitat. Habitat, more than anything else, determines density and composition of wildlife species. Burned areas of different ages, together with unburned areas, greatly enrich the diversity and numbers of wildlife in most vegetation communities. Animals escape the heat of fires by flying or running away, going below the ground, hiding in rock outcrops, or seeking islands missed by the fire.

Fire studies in California showed no harm to cottontails, wood rats, mourning doves, quail, and several other species of birds. In fact, the numbers of all animals increased immediately after the fire. In east Africa, the only report of any mature animals being killed by fire was after a fire in 1869 in which an elephant and buffalo were killed. Occasionally a few very young animals are killed by fires. However, improved habitat allows for increased wildlife beyond the losses due to mortality.

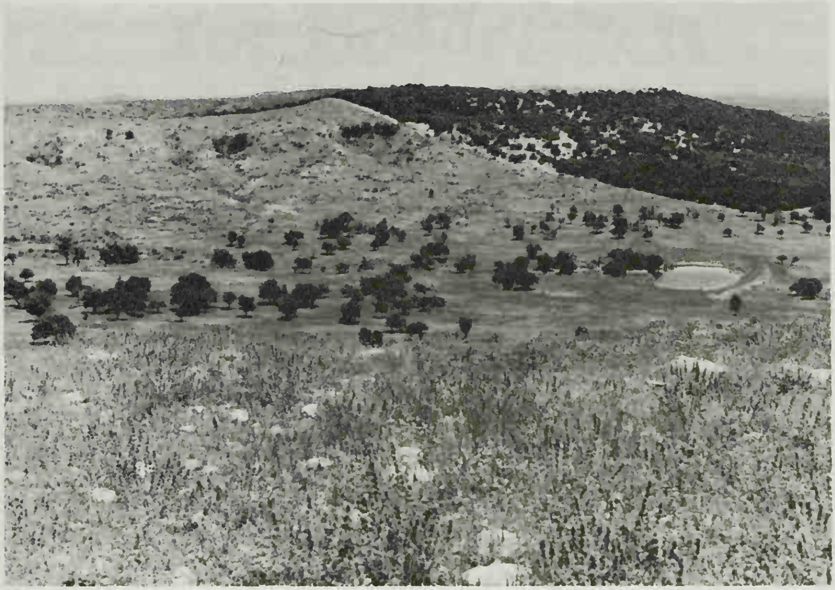
Pollution. Airborne particulates are the primary pollutant of fires, although particulates are short-lived. Hydrocarbons are another combustion product, but few, if any, appear in the combustion of wood products that are important in photochemical reactions. Carbon monoxide is released by combustion, but oxidizes readily and does not pose an immediate threat to people, plants, or animals.

Fire Management

Today, National Park managers are letting fire take a more natural role in vegetation management. Fires are used with discretion to restore parks to their original condition. Fire research during the 1970's and 1980's throughout the United States and Canada is providing the basis for using fire as an effective management tool.

Use of fire is being accepted more slowly and cautiously in forests of the western United States and Canada than in shrub and grassland ecosystems. Personnel of land management agencies have seen many devastating wildfires and are not convinced that the benefits of prescribed burning outweigh the risks. Unfortunately, the risks are becoming more serious, and western forests will need a massive infusion of hazard-reduction burning to reduce fuel buildups that create the potential for large catastrophic fires. These fuels must be removed with fire by highly experienced personnel before maintenance burning can be used safely and at reduced costs.

Prescribed Burning. Prescribed burning is a reasonable way to reintroduce fire into many ecosystems, but too much emphasis has been placed on its risks. Based on research at Texas Tech University on more than 300 shrub and grass fires, including burning volatile fuels such as juniper and chaparral, prescribed burns are relatively safe if personnel are



Fire has removed shrubs and enhanced grasses and forbs (foreground), contrasting with an untreated area of ashe juniper (upper right) in native Texas grassland. (Henry A. Wright, Texas Tech University)

experienced (trained for two or three burning seasons in the field) and cautious. The use of fire can be frightening, however, and many necessary burns are not done because of fear. Judgment, experience, and decisionmaking ability are necessary qualities for anyone conducting a prescribed burn.

Conducting wildland fires is still dangerous. People must be informed about these dangers—what they are and how to make plans to cope with unexpected fires. Burning with low subsoil moisture in the Great Plains usually leads to low grass yields, whereas burning with high subsoil moisture leads to high grass yields and, therefore, should be done during wet years. Wildfires in some parks and wilderness areas are permitted to burn under certain weather conditions, but if there is a chance of a catastrophic stand-replacing fire that has unacceptable risks in terms of lives and property, the fire is suppressed as quickly as possible. Unexpected fire behavior is always a threat, and only individuals with years of experience can attempt to forecast the dangers.

After a Burn. Management after a burn is important to the success of a burn. Wildlife and grazing animals will frequently concentrate on burned areas because the vegetation is more accessible, palatable, and nutritious. For this reason prescribed burning is generally conducted on a large management-unit basis (1,000 acres or more). If small areas are burned within large areas, animals will concentrate on the burn, even 2 years afterwards with deleterious effects on the vegetation. In Texas, burns have greatly improved rangeland pastures, and all of them have been grazed within 3 to 7 months after the burns.

Versatile Tool. Fire can achieve many objectives simultaneously in diverse plant communities. It is a natural component of most ecosystems and frequently the only management tool available to achieve particular objectives. Fire can help to achieve management objectives such as fuel reduction, seedbed preparation, disease control, thinning, suppression of shrubs, removal of litter, increased herbage yields, increased availability of forage, and improved wildlife habitat. Fire often is the least expensive management alternative.

The Floodplain is a Special Place

Joseph S. Haugh, civil engineer, and
Donald B. von Wolffradt, river basins coordinator,
Soil Conservation Service

Rain, melting snow, high tides, and even ice breaking up can start a flood. Flooding is a natural phenomenon. Floods may occur at any time in any location in the United States. In the northeast, south, and midwest, the larger rivers tend to flood in late winter and in early spring. Streams in the Mountain States flood frequently in late spring and in early summer when the snowpack melts. Small headwater streams usually flood after a brief, severe storm.

States along the Gulf of Mexico and the Atlantic Ocean have severe late summer and fall storms from hurricanes. Hurricanes, when they move inland, can cause great rains to fall in a short time. Floods from hurricanes devastate large areas.

Kinds of Flooding

Riverine Flooding. Generally, the flow in any water course is conveyed naturally within a stream channel. Nature's way of handling the excess floodwater is through use of a "relief valve" known as a floodplain. A floodplain is an area that adjoins a body of water and can be covered by water from an overflowing stream.

Upstream vs. Downstream Flooding. Upstream flooding on smaller riverine streams is usually associated with flash floods. Downstream and major river flooding lasts longer, has a longer warning time, and inundates larger areas than upstream flooding. Flood damages are about evenly distributed between upstream and downstream locations.

Nonriverine Flooding. Coastal areas flood from unusually high tides. These areas experience severe flooding when high tides and high stream flows happen simultaneously.

Alluvial fans are sediment deposits at the mouths of streams. In western States, floods may overflow these areas and may run in any direction. Even though a flood can be forecast, the area flooded cannot.

Flat lands may be flooded from water that has no place to run off. Sometimes flat land flooding is caused by ground water which surfaces.

Other Potential Hazards. Dams and levees benefit society by reducing flooding, but they also are a potential flood threat. Most dams are designed and located so that the potential for damage in event of failure is local. Even small dams, however, can pose a potential flood threat to downstream areas.

Efforts to Control Floods

The Federal Government had virtually no responsibility for controlling floods or reducing damages for the first century and a half of our Nation's history. One of the earliest Federal actions in comprehensive water resource planning was the establishment of the Mississippi River Basin Commission in 1879. This commission was directed by the Congress to prepare plans for navigation and flood control on the Mississippi River. As flood losses continued to mount, Congress authorized Federal construction for flood control measures in 1917 along the lower Mississippi and the Sacramento Rivers. In 1928, the Federal Government became responsible for the entire Mississippi. Passage of general flood control acts and the formation of the Tennessee Valley Authority in the 1930's brought further Federal participation in flood control.

Flood Damages and Deaths

Records kept by the National Weather Service show that flood damages have steadily increased since 1900, despite efforts by people and governments to control or reduce the flood losses. In addition, 4,000 people have been killed by floods since 1925. According to the Second National Water Assessment, flood losses in this country now average $3.4 billion annually.

Economic expansion and unwise development on floodplains were responsible for increasing flood damages. Flood control projects inspired a false sense of security and invited people to take unwise risks.

Risk of Floodplain Use

While grasses can tolerate flooding one or more times each year without excessive damage, cultivated crops can be completely destroyed when flooded during critical growth periods. Some crops are impractical to grow in areas that flood often.

Most zoning ordinances use a flood having a 1-percent chance of occurring in any year as a minimum basis for residential development. Uses that warrant a higher standard are nursing homes, hospitals, and important records centers.

Appropriate land use should be based on risk. Decisions about the risks, degree of flooding, and proper land use need to be based on technical facts. These facts need to be conveyed to the public so that timely and informed land-use decisions can be made.

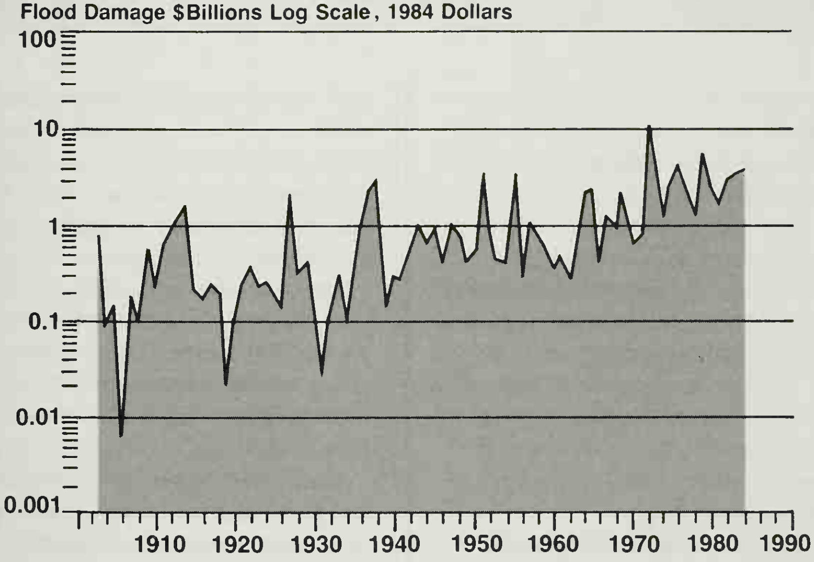
Management Techniques

Floodplain management, in part, is taking steps to avoid or reduce flood damage. They include not building anything on a floodplain if it can be avoided; making a risk assessment of any floodplain project or activity;

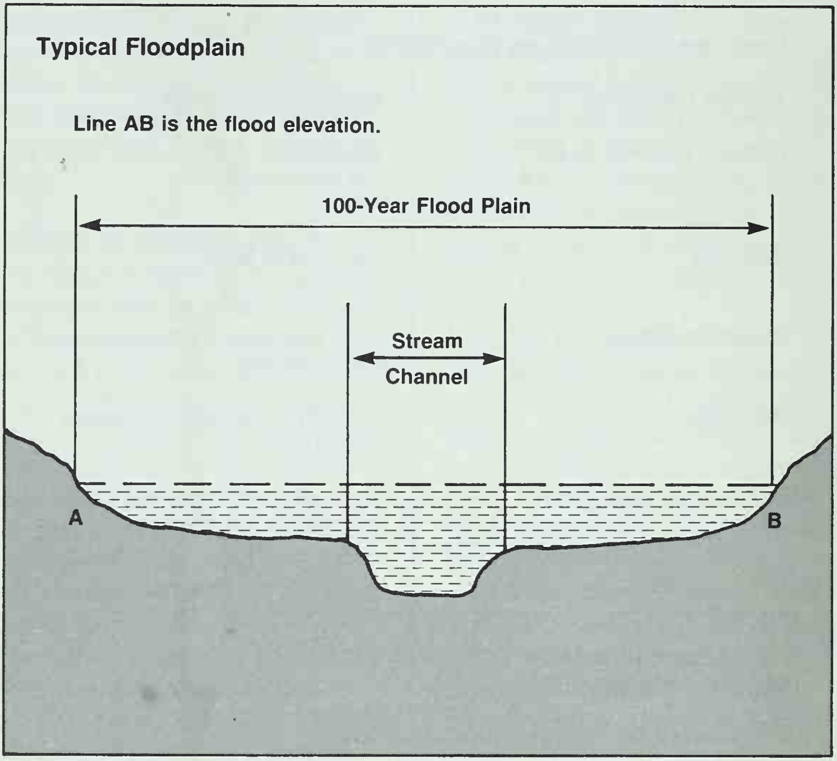
Land Use Guidelines on Floodplains

Average Frequency	Appropriate Land Use
Frequent (1/2 yr to 10 yr)	Woodland Low value crops Wildlife
Infrequent	Higher value crops Recreation
Base flood (100 yr)	Flood Insurance Act Standard for residential use
Rare flood	Hospitals, buildings with valuable contents
Probable maximum flood	Social considerations—recognition that flooding is a possibility

Annual Flood Losses in the United States



Source: NOAA/NWS Flood Data Base



generally protecting human safety, health and welfare; and preserving and restoring the quality of the floodplain environment.

The techniques of floodplain management fall into two broad categories: (1) measures for controlling floods and (2) measures for controlling how people use a floodplain.

Measures for controlling floods include dams, levees, and channels. Some flood control from land treatment measures helps to reduce runoff and erosion, too.

Early warning of an impending flood gives people time to reduce property damage and safeguard lives.

Local regulations also can keep incompatible development out of areas subject to flooding. Communities can purchase land or flood easements to dedicate floodplains to compatible uses such as parks or open spaces.

Individuals can reduce their vulnerability to flood damage by flood proofing. Permanent measures include raising utilities above the probable flood level or sealing low entrances from flood waters.

Flood loss insurance can spread the cost of flooding over a number of people in a community. Post-flood recovery programs help people to recuperate from the flood.

The best way to avoid flood damage is to avoid building on a floodplain. Some ways to lessen flood damage are to build on ground slightly higher than the surrounding area, raise the house, or reshape the landscape to include a ridge or small dyke around the house. (R. L. Wilkes, SCS, GA-1,086)

Floodplain Management Assistance

Government Help. Floodplain management is usually a local and State government responsibility. If the problem is too big for them, assistance may be available from the Federal Government.

During the last 30 years, the Federal Government has assisted most of the Nation's 20,000 flood-prone communities. About 18,000 communities have identified flood problems and adopted floodplain management regulations. Various programs offering floodplain management assistance are under the U.S. Department of Agriculture and several other Federal Departments and agencies.

Individual Initiative. Individuals make decisions concerning homes and farmsteads already on floodplains, the kind of farm enterprises to run, and the crops to grow. They control the land use, but suffer the losses when flooding occurs. Individuals can reduce exposure to flooding by:

- Changing land use on lands that flood most often to low value crops, forest land, or wildlife use.
- Moving livestock, equipment, materials, and family to higher and safer locations.

- Installing livestock mounds as refuge from floods.
- Making sure that additions or improvements to farmsteads are high enough to avoid future flooding.
- Raising electric motors, controls, household appliances, and electric connections above the flood line.
- Wrapping electric motors and equipment that cannot be moved with waterproof sacks.
- Preparing a farm and family flood evacuation plan.
- Relocating all or part of farmstead to a higher elevation.
- Contacting local officials to determine how deep and how often flooding can occur.

A Nation is Land

Richard Arnold, director, Soil Survey Division, Soil Conservation Service

A nation is real estate—a geographic entity—a nation is land. Cultural, religious, and economic influences contributed to its historical development, but the soils of these United States also played a key role in shaping this society. "Perhaps no other country," claimed an eminent American soil scientist, Charles E. Kellogg[1], "has greater contrasts in soils and landscapes."

Americans have always valued their wealth of diversity as a national strength and a uniquely American heritage.

New England

The glaciated landscapes in New England beyond the narrow strip of sandy and stony beaches were forested and consisted of sandy moraine ridges, gently rolling plains of sandy and stony loams, nearly level stream terraces, and alluvial floodplains. The climate and glacially derived soils were similar to some areas in England; thus, the techniques and systems of farming were transferred by these settlers.

Trees were felled and burned adding their meager supply of nutrients to the modest amounts in the topsoil. After several years of cropping, the yields suffered and, unless lime and fertilizer were supplied, grain and hay fields had to compete with weeds, shrubs, deer, cattle, and nature.

Crops and grazing cattle soon depleted the inherent fertility. Native plants were not well adapted to grazing. More and more land had to be cleared, with the same consequences.

Floodplain soils were friable, darker, and better for farming, but floods and the need of industry reduced their availability for farming. Clearing, burning, farming, abandoning, and opening of new land became a repetitive agricultural cycle for many.

Even as people moved west and south along the Great Valley and Appalachians, in search of new farms, some settlers stayed put to learn that soils (Ochrepts and Orthods) responded well to good husbandry—liming, fertilizing, and rotating grains and legumes. Nearly self-sufficient small farms produced fruit trees, berries, grains, grasses, wood products, and livestock. Streams and rivers were harnessed for power; mills and industries developed.

Experimentation established that a sustainable agriculture was possible, and New England farms produced generations of independent, self-sufficient, industrious people with a strongly conservative outlook.

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[1] Charles E. Kellogg, *The Soils That Support Us*, NY, Macmillan Co., 1941

The Appalachians

The Appalachian Mountains with their northeast-southwest valleys funneled the explorers into the Ridge and Valley, Piedmont, and Appalachian Mountain Regions. Much of the land was subject to erosion that hastened the decline of productivity and encouraged additional migrations. Life was hard, the land did not provide enough to live on, and other livelihoods were sought in towns.

Central Atlantic

The settlers in Virginia expanded along the tidewater peninsulas of the major rivers. Nearly level sandy soils were cleared and tobacco was grown for trade. Although the soils were sandy and not stony (Udults), they soon appeared to be exhausted.

The nutrient reserve in these soils is less than that in the soils in New England; however, they also respond well to good husbandry. Subsistence farming was common, but movement west was blocked by the Appalachian Mountains. The gradual adoption of crop rotations with legumes and grasses helped to restore productivity on the clayey upland soils (Udults and Udalfs), and tobacco and cotton were managed successfully with enough labor. This led to a mixed land ownership pattern of small family-operated freeholdings and larger plantations with slaves and indentured servants. Streams did not lend themselves to development for water-powered, labor intensive industries as in the north.

Farther south, in Carolina, settlers from the Barbados found flat wet sandy soils (Aquents and Aquults) that could be developed as plantations and slave labor used. Rice and indigo became major plantation crops in this hot, humid coastal region. Beyond the coastal strip were large expanses of sandy pine barrens (Psamments and Udults) stretching from Virginia all the way to Texas. Most of these soils contained a slowly permeable clayey zone deep in the subsoil.

The inherent fertility was low and once the organic matter of the surface was used, crop productivity remained low unless lime and fertilizers were applied. Neither of these was readily available in the region. This barrier to migration lasted into the 19th century, and settlement of the frontier in the hilly portions was more influenced by migration from the north along the Appalachians.

The agriculture in the Piedmont with its rolling hills and wooded slopes (Udults mainly) was a mixture of small farms and plantations. Cotton became a staple crop, but tillage practices left the soils bare too long during heavy rainstorms. Gullies and sheet erosion commonly occurred throughout the area. The Piedmont soils are geologically old and have been weathered and leached of most of their nutrient reserves. They have a low ability to retain added lime and fertilizer. Proper management is important. People searched for new land and a chance to obtain a better way of life.

The search for new frontiers enticed people westward. In New York the Erie Canal was completed, and opportunities to go into Ohio and farther west were feasible for the previously landlocked farmers of New England. The Big Valley in the Appalachians had been settled, and people went over the mountains to the western plateau and beyond. From Virginia and the Carolinas people trekked over or around the Appalachians into Kentucky and Tennessee and into the Black Prairie lands in Alabama and Mississippi.

The South favored further expansion of cotton plantations as the owners took up residence in the ''black soil'' grasslands (Uderts and Udolls) leaving the forested rolling hills for the smaller freeholdings. The rugged hills in eastern Tennessee, Kentucky, and West Virginia were passed through as quickly as possible because only narrow valleys with alluvial soils (Fluvents and Ochrepts) were productive for cropping. The gentler slopes of the limestone belt farther west (Udalfs mainly) responded well to the technology and skills of the farmers.

Old glacial lake beds in Northern Ohio and Indiana were flat and often wet. The dark soils (Aqualfs and Aquolls) were treeless, but once the sod was broken and some drainage applied the soils were productive. Much of this area remained poorly developed until the late 1800's when large drainage projects were undertaken.

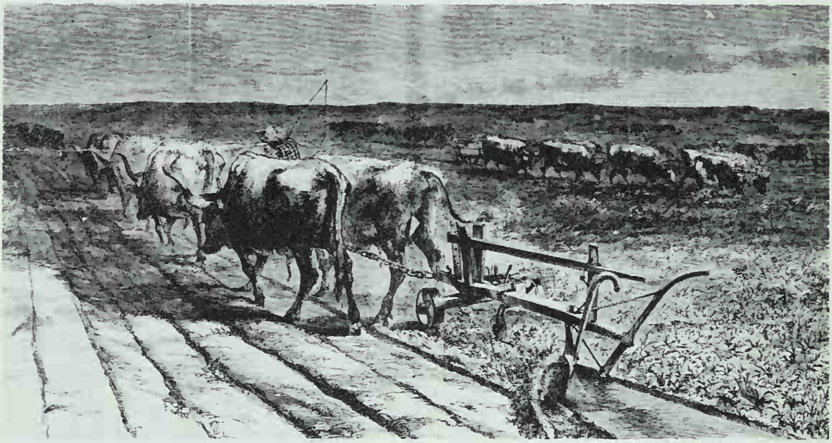
The Midwest

After the Civil War, immigrants again swarmed westward. Those who went into central and northern Michigan cleared the forests and cropped briefly before finding that the undulating soils (Orthods and Ochrepts) were of low inherent fertility and crop choices limited.

When people moved into Illinois, Iowa, Minnesota, and Nebraska, they observed flowing fields of Prairie grasses waving in the winds and few trees. Clearing land no longer consisted of the drudgery of cutting trees, rather it was a struggle with the tenacious deep rooted grasses. Ingenuity soon provided new plows that could and did break the sod and permit farming the thick black friable soils (Udolls and Aquolls).

As the soils were cropped, productivity remained high and the soils did not appear to degrade and erode like the soils they had left behind. Many of the soils in the Corn Belt approach the ideal arable soils that have good tilth, hold moisture, and supply air, water, and nutrients in a timely and appropriate manner for the crop plants. Farmers could produce surpluses and engage in profitable trade as well as provide most of their own home needs. With rich, fertile soils, favorable climate, and good infrastructure the people became conservative and complacent.

Another wave of migration moved



Breaking the raw Illinois prairie was difficult work, but worth it—the soils were fertile and productive. (Library of Congress, LC-USZ62-22111, from a Harper's Weekly *wood engraving, 1871)*

out of Tennessee and Kentucky into Arkansas and Missouri. The soils were moderately productive (Udalfs mainly) but subject to erosion and needing careful management. The people were not as self-sufficient as those on the Udolls farther north.

The Plains States

The next major push was homesteading the short grass prairies of the Great Plains. In the north the soils are deep, dark, and fertile (Borolls and Ustolls), but the moisture is such that winter wheat in the north and spring wheat in the south are the major crops. The weather patterns are unpredictable with droughts followed by bumper years—boom and bust. The individuals who live with the limited cropping possibilities are fiercely independent but liberal. Using the land for range is an alternative. In the southern plains wheat is still dominant with cotton and cattle important. The soils (Ustolls) are reddish and highly fertile, but with uncertain rainfall. Prairie grasses were plowed up and crops planted; rains did not come often enough and the winds scorched the earth and blew soil across the land. This area later became the Dust Bowl and dramatized the extreme sensitivity of some of our American land.

The Southwest

In the Southwest the climate is dry, and the range influences the lives of most people. Irrigation made the edges of the deserts green. The dry soils (Orthids and Argids) respond to management and have mineral nutrient reserves. The northern deserts in Nevada and Utah are also predominantly rangeland and in some areas the land is desert wilderness. Much of the land is in public domain and managed by government agencies. The need for assistance to develop water resources or backstop the disasters caused by devastating weather patterns influenced the attitudes of the early settlers.

The West Coast

The West coast is an area of winter rainfall, hot dry summers, and limited choices of crops unless water is available. With water the possibilities are almost unlimited, but it took years to learn how to manage the salty areas (Salorthids), those dominated by subsoil pans (Durixeralfs) and dry hills (Xerochrepts). Ranching and farming were not easy ways of life, and isolation from the eastern regions strengthened attitudes of independence.

The grasslands of the Palouse in Oregon, Washington, and Idaho were much like the Great Plains. Slowly the grass was replaced by wheat. Rainfall was relatively low and often unreliable. The spring melt of frozen ground contributed to dramatic erosion of the billowy landscapes. Rugged individualism tinged with an understanding of adversity and gratefulness for assistance was the legacy of this environment, reminiscent of those who settled the Great Plains.

The continent had been crossed—a richly diverse and challenging landscape had become one nation.

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Keeping Track of the Snow

David E. Johnson, snow survey program manager,
Soil Conservation Service,
Portland, OR

Snow greatly influences use of the land in the mountainous western United States. Water availability governs this semiarid region's economy with about 40 million acres under irrigation. More than 70 percent of the West's surface water comes from mountain snowpack. During the winter and early spring, these extensive snowpacks function as natural reservoirs accumulating frozen water with each new storm. Melting releases water for downstream uses in the spring and summer.

Snow Surveys

Around 1900, Professor James Church from the University of Nevada at Reno developed and applied scientific procedures to measure the amount of water in the snowpack on Mt. Rose and the related levels of Lake Tahoe and used them to forecast the resulting runoff into Lake Tahoe.

Early Water Supply Forecasting. Most Western States started a snow measuring and water supply forecasting service as people became more and more dependent on that source. The state engineer or university got the job although irrigation districts and hydropower companies often conducted their own local surveys.

Snow Survey Program. The drought of 1933-34 brought demands from the West, particularly agricultural interests, for a consistent, regional water supply forecasting system based on accurate snowpack measurements. In 1935 Congress gave the U.S. Department of Agriculture's Bureau of Agricultural Engineering this responsibility. The Snow Survey Program, as it came to be known, was placed in the Soil Conservation Service (SCS) in 1939. SCS standardized measurement and forecasting methods. It has been a highly cooperative effort involving Federal, State, and local agencies, Canada, numerous private entities, and individuals.

The Snow Survey Program started with a small network of measurement sites called snow courses located high in the mountains. Once a month during the snowpack season teams of trained snow surveyors trekked into the mountains on skis and snowshoes to measure the snowpack, using procedures similar to those developed by Dr. Church. SCS personnel in each State made forecasts based on the

While SCS-directed snow surveys are now automated, manual techniques still play a role. Water content of the snowpack is determined from the weight of a snow sample collected in a hollow tube pushed through the snow. (Tim McCabe, SCS)

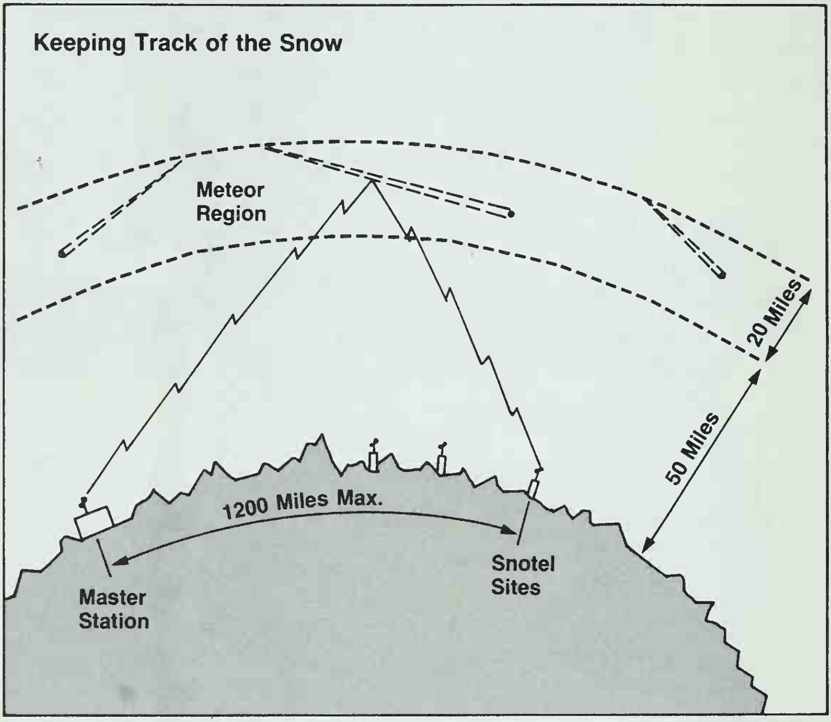
month's measurements. Water Supply Outlook Reports described conditions in every major drainage basin. The network of snow courses gradually expanded to meet public demand.

Uses for Snow Data

Snow data is useful in assessing threats posed by snow to highways and railroads, the survival of big game animals on winter range, and the reproduction and spawning of certain trout. Snow data helps people interested in the structural safety of buildings that could be damaged by heavy snowfalls and helps people involved in snow-based recreation.

Automated Snow Surveys

Sudden intense storms high in the remote mountains can deliver an unexpected increase in the snowpack. Avalanche hazards appear suddenly by changes in snowpack, temperature, or



wind conditions. Even mild weather can cause problems: unseasonable warm spells can result in rapid melting and severe floods downstream with little or no warning.

All these events can, nevertheless, escape detection by a monthly manual snow survey. So hydrologists developed automated methods of measuring snow.

Snow Pillows. Flat containers filled with an antifreeze solution were developed and called "snow pillows." The water content of the snowpack was determined by the weight of the snow on the pillows. This technique permitted continuous monitoring of the mountain snowpack.

Transmitting Data. A new radio communications technology called meteor burst is used for transmitting data to a base station. SNOTEL (for SNOwpack TELemetry) is the name of this new automated data collection system.

In meteor burst communications, very high frequency radio signals are bounced off the ionized trails created by the countless meteorites that enter the earth's atmosphere daily in a zone 50 to 75 miles above the surface. The angle of the radio wave paths through the earth's upper atmosphere allows transmission of signals over distances up to 1,200 miles. Communications between a remote station and a base take place over a single meteor burst link that lasts only a fraction of a second.

SNOTEL Sites. About 550 solar-powered, computer-controlled SNOTEL sites are now in operation in the West. Each site collects and stores data on snow water content; precipitation; minimum, maximum and average temperatures; and other sensor readings.

Centralized Forecasting System

Once a convenient and cost effective way was found to gather snowpack and related data, a complementary restructuring of the Snow Survey Program created a regional forecasting and data base management facility located in Portland. An extensive system of computerized data bases, forecasting models, and soil and water conservation planning tools called the Centralized Forecasting System (CFS) was developed.

Historical and current SNOTEL and snow course data, streamflow forecast information as well as certain climatological and streamflow data needed for conservation planning are available to anyone with a computer terminal or microcomputer equipped for telephone communications. No access fee is levied for retrieving information. Numerous Federal, State, and local agencies, as well as private cooperators, rely on CFS for information about the high mountain snowpack to make daily decisions on seasonal crop water planning, reservoir operations management, power generation planning, irrigation scheduling, flood and drought preparedness planning, recreation scheduling, fish and game management, and avalanche hazard evaluation. And these are but a few of the applications this data can be put to.

While CFS provides the most current information, the printed monthly Water Supply Outlook Reports, also automated through CFS, are used extensively. The modern resource manager can obtain the latest accurate information through highly efficient automated technology.

Beating Back the Bugs in the Forests

Charles I. Shade, retired public affairs specialist, and
Dennis R. Hamel, pesticide specialist,
Forest Pest Management, Forest Service

Insects and disease kill enough trees each year to build over 800,000 single-family homes. As spectacular as the devastation left by the eruption of Mount St. Helens was in 1980, insects and disease kill 70 times that much timber *every year.*

Modern forest practices can create plantations of even-aged, single-species trees—an invitation to the voracious insect pests for which they are hosts.

Control, 1987

Integrated Pest Management (IPM) is the organized approach to pest management today. A decisionmaking process, it uses a full range of tactics: biological, cultural, manual, mechanical, thermal, and chemical. Analysis of site-specific pest situations is the first IPM step and basic to determining the method or combination of methods most effective, least costly, and least harmful to the environment, people, and wildlife.

Biological Control

Pheromones, pathogens, predators, and parasites are among the newest weapons of the IPM war on pests. They are usually effective against a single or related species and, because they occur naturally, are considered harmless to the environment.

Pheromones. Insects produce and perceive minute amounts of volatile chemicals (pheromones) that attract mates, signal danger, blaze trails to food, and mediate many other interactions. Pheromones are used to trap insects for surveys and suppression. Sex pheromones are used to confuse males so that they cannot find mates.

Pathogens. Disease-causing agents can be effective pest management tools. The bacterium *Bacillus thuringiensis* is widely used against lepidopterous defoliators such as tent caterpillars, webworms, gypsy moths, tussock moths, and spruce budworms.

The Forest Service has developed, produced, and distributed a nucleopolyhedrosis virus (NPV) for the Douglas-fir tussock moth (DFTM). In Idaho in 1986 a suppression project showed 3 percent of DFTM larvae died of the virus outside the treatment area; 30 percent died of the virus where NPV was sprayed.

The fungus *Beauvaria bassiana*, the nematode *Neoaplectana* spp. and the protozoan *Nosema locustae* are pathogens that have been used with varying degrees of success on lepidoptera, bark beetles, and grasshoppers respectively.

Predators and Parasites. Birds are important natural enemies of insects. Evening grosbeaks, for example, were found to eat 8,900,000 western spruce budworms over 55 days on a 1-square-kilometer site in Washington State in a 1984 study. The birds concentrated their feeding in the top one-third of trees while predatory ants dined on the budworms in the bottom two-thirds. Managing forests for birds and ants has the potential to mitigate future budworm epidemics.

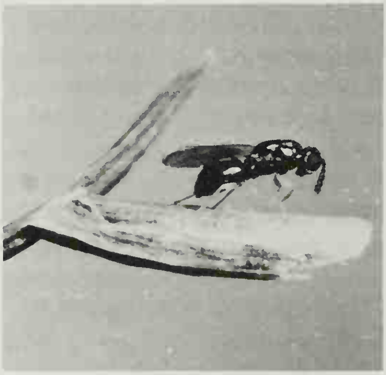
Rearing and releasing parasites works too. The pine sawfly that attacks eastern white pine and Christmas tree plantations in the South is being controlled by the tiny wasp *Monodontomerus dentipes*. And the larch casebearer, a defoliator of western larch, is being held in check by two introduced wasps, *Chrysocharis laricinellae* and *Agathis pumila*.

Silviculture

Techniques for suppressing insect pests are often spectacular, but preventing them is better. Cultural control methods, requiring long-term planning, offer practical solutions.

Early Harvest. Harvesting trees before damaging population levels of pests are reached is effective against insects that attack maturing trees.

Selective Cutting. Thinning and cutting for commercial and precommercial sales result in greater vigor of remaining trees, making them less susceptible to pest infestations.



Chrysocharis laricinellae, *a tiny wasp (.05 inches long), controls the defoliator larch casebearer by parasitizing its larvae. (Roger B. Ryan, FS)*

Seed Source. Selecting the proper seed source for regeneration is directed toward matching the planting site with both species and climatic variants of trees and seeds to produce the greatest stand vigor.

Species Diversity. Pure strands of a single species offer vast food supplies to insects of which they are hosts. Supplemental planting, altering the percentage of species within a stand, and allowing forest succession to reach a natural climax after fires and insect epidemics will produce forests of greater resistance to pest attack.

Host Resistance. Selecting and producing trees and seeds from varieties that resist pests is a long and costly process in forestry. But it is effective and environmentally sound.

Clean Cultivation. Plowing under last season's crop to destroy developing pests is highly successful in agriculture. An example in forestry is clearing slash to prevent infestations of *Ips* beetles.

Timing. The multiplicity of insect pests in forests makes timing critical. For example, thinning ponderosa pine to control mountain pine beetle, if improperly timed, can result in epidemics of *Ips* beetles.

Physical and Mechanical Control

Among the oldest control methods, many of these techniques are still effective, and some have not been fully explored.

Heat, cold, humidity, and light affect insect pests in various stages of their development. Sunlight, kiln drying, cold storage, and the use of plastic heat traps in nurseries are methods that have pest control applications.

The use of sound has long been regarded as a possible deterrent, but results have been disappointing. Barriers, however, are effective; adhesives, for example, reduce populations of spring and fall cankerworms and gypsy moths as they ascend trees. Handpicking is still effective, particularly on high value plantings and in urban forestry.

Mechanical destruction is a widespread technique, using equipment to crush or chip logging slash, seeds, cones, twigs, shoots, branches, or brood trees that serve as feeding, overwintering, or breeding sites.

Conventional Pesticides

Conventional pesticides are an integral part of IPM and are apt to remain so as long as pest situations exist for which no effective alternative can be found or developed. Such conditions occur when vast areas are infested, rapidly rising or migrating pest populations spring up, inaccessible terrain limits options, and suddenly introduced foreign pests are involved.

Admittedly, the Forest Service uses few pesticides and in small quantities, but when epidemics threaten highly valuable forest or range land resources, pesticides are often the fastest acting, safest, and least costly means of protecting our renewable resources.

Of the 191 million acres of forest and range land administered by the Forest Service, about 700,000 acres are treated annually with pesticides; that's about three-tenths of 1 percent. Many other acres are treated using the other alternatives described. The total volume of active ingredient used in the United States annually is slightly less than 1 billion pounds. Agriculture accounts for about 75 percent; homeowners and others, 24 percent, and the Forest Service less than 1 percent.

Unquestionably, the use of conventional pesticides is decreasing as more reliance is placed on biologicals and other IPM alternatives. But dramatic explosions of pest populations call for fast action with proven remedies, as happened in 1983 with the western spruce budworm, and in 1985 and 1986 with grasshoppers. Grasshopper epidemics alone accounted for over 600,000 acres of treatment each year on National Forest System land in 1985 and 1986.

The Future

Pesticide research promises exciting innovations. A new concept in pheromone use is releasing them to entice predators and parasites into infested areas. Releasing sterile males to reduce populations and genetically altering insects to produce less prolific offspring are two avenues that may lead to practical application in forestry.

Biotechnology, manipulating the building blocks of genetic information to create new life forms, may lead to the engineering of more effective natural enemies of pests.

Biosynthetic studies reveal enzymes in pheromones that may be inserted into a plant itself to disrupt the mating of pests. By manipulating light, darkness, temperature, and food, the internal rhythms of insects can be shifted to affect life span, mating, and maturation. So called natural pesticides can be developed from plants like the neem tree (*Azadirachta indica*), which can be grown on land marginal for other crops and which produces an environmentally safe insecticide extracted from its seeds.

New formulations of existing pesticides are being developed to increase effectiveness. Time-release capsules are one example.

Are we beating the bugs? Probably not. But we're catching up. Each year we do better in protecting our renewable resources in ways that are economically sound, environmentally safe, and acceptable to those who love the land.

When Wildfire Comes Knocking

John F. Marker, fire prevention officer, Forest Service, and
Gary O. Tokle, senior fire service specialist, National Fire Protection Association, Quincy, MA

More and more homes are being built in forests and brushlands where the risk from fire is high. (Los Angeles County Fire Department, FC-VII-B)

In 1985 the United States experienced the most severe wildland fire losses of this century. More than 83,000 fires burned over 3 million acres, destroying or damaging more than 1,400 structures and causing the death of 44 persons. Combatting this devastation cost Federal, State and local fire agencies, as well as private industry, more than $400 million. The damage to property and natural resources was more than $500 million. This loss of lives and property occurred all across the United States, from Florida, Virginia, and New England to Idaho, Nevada, and Central California.

The Nation experienced another large outbreak of wildland fires—about 100,000—in 1986 causing the evacuation of 15,000 people in Michigan, New Jersey, North Carolina, and Idaho. Fortunately, these fires did not cause the loss of lives and structures that occurred in 1985, but nine fire fighters died. A massive commitment of fire fighting forces and some luck prevented greater losses.

Expanding Wildland/Urban Areas

The population began moving from urban to suburban living after World War II, a phenomenon that has greatly expanded contacts between wildland and urban settings. While this trend has increased the general population's appreciation for our forests' amenity values, it also has greatly increased the number of primary residences, second homes, and retirement homes located in forests and brushlands. Vast areas contain high-value properties intermingled with flammable, native vegetation.

Structural fire losses are increasing dramatically as more people build and live in proximity to flammable plant communities, and major losses of life occur. The problem is not unique to southern California. Residential and commercial development into high fire-risk areas has extended throughout the Nation—from the Georgia Piedmont and the sand plains of central Michigan to the Rocky Mountain foodhills near Denver and the forests of northern New England.

Current fire protection practices make it unlikely that fires ever will reach the huge proportions of those in 19th century America, but the risks to life, property, natural resources, and economic welfare are much higher today then ever before. Even small fires can kill. In 1985 three homeowners died when an acre fire swept into their subdivision. As the contact between urban and wildland areas continues to expand, fire protection must change to more effectively prevent and suppress smaller, fast-moving single and multiple wildfires.

Protecting Wildland/Urban Areas

The task of protecting lives and property from wildfires where wildland touches urban land poses one of the most critical problems faced by fire protection agencies. Fire managers cannot reliably predict fire behavior in the mixture of structures, ornamental vegetation, and wildland fuels of a potential fire site. Physical fuel properties and moisture relations in these areas are not well understood, as they are governed by both nature and people. Possible relationships among building and landscaping location, design, and construction, with respect to terrain and other structures, add to the complexity of fire behavior. For example, "spotting" (fires starting from flying embers) is especially difficult to forecast because of the diversity of firebrand materials and unusually complex windflow patterns. Yet spotting is the chief cause of structural fire ignitions in wildland/urban areas.

Prescribed fire to reduce hazards, that is, fire purposely set to remove undesirable vegetation is made difficult by legal, political, and environmental concerns. Damage liability to intermingled private holdings is a significant deterrent. Frequently, living next to wildland precludes the use of prescribed fire. The challenge is to manage fire hazards while maintaining or enhancing environmental and economic values.

Overcoming Unawareness

Many property owners are unaware of the wildfire threat, and fire safety ordinances and building codes are frequently inadequate, unenforced, or disregarded. An example is the use of flammable roof materials in high fire hazard areas. The design of subdivisions continues to defy fire safety. Many areas include narrow, winding, or deadend roads with inadequate water systems. Lots frequently are too narrow to permit effective vegetation removal. Without strong motivation to change, homeowners and developers will continue to produce and maintain these dangerous living environments.

Need for Information Exchange

Most forest fire fighters are poorly prepared for fighting structural fires, while municipal fire departments are not always fully trained or equipped to fight wildland fires. Although relatively new organizational systems for integrating fire protection resources and personnel show promise, the special demands of fires in wildland and urban contact areas often force fire fighters to perform unfamiliar tasks. The need to meld structural and vegetational fire expertise to fight these fires remains.

The first national conference dealing with this challenge was held September 1986, when 100 experts from the United States and Canada gathered in Denver, Colorado for an intensive 3-day conference. These experts quickly realized that both the problem and the solutions did not involve just fire fighting agencies, but also building-design professionals, developers, insurance personnel, State and local government officials, planners, sociologists, researchers, homeowners and others. People in many sections of the United States and Canada already had begun addressing various pieces of the problem, but they needed a mechanism to exchange information about fighting fires in wildland and urban contact areas. The following high priorities were established.

- Effective techniques and strategies to assess and manage fire hazards in wildland/urban areas.
- Aids for planning, budgeting, and training personnel for increased involvement in the residential/wildland areas to ensure a balanced capability to conduct structural and wildland fire suppression.
- Effective ways to educate property owners, land developers, insurance carriers, and local planners about vegetational fire problems and solutions.
- Fundamental knowledge about the physics of fire behavior in wildland/urban areas.
- Knowledge about the relationships of building design, material, and landscaping to fire hazards and fire behavior.
- Improved understanding of why people build fire-prone homes in highly flammable areas and how they respond to efforts to involve them in reducing their vulnerability to fire.

Sharing Responsibility

Who is responsible for the solution—the fire protection agency, the homeowner, the county planner? The responsibility for fire protection cannot be relegated to a single element of society. It calls for the combined efforts of governmental agencies, the private sector, and individuals.

A national report, *Wildfire Strikes Home,* grew out of the 1987 Denver conference. This report and a video version were used by America's wildfire and structural fire organizations. Both help those wishing to develop local wildland/urban fire protection programs.

Several States now have executive committees to address the specialized fire problems discussed here. The national Smokey Bear Program began targeting wildland/urban residents with fire prevention messages. Technical symposiums to bring builders and architects together with fire professionals were arranged to address community wildlife and structural fire issues.

For the first time, major national leaders in wildland and structural fire protection have joined to attack a shared fire problem—wildfires that strike home.

The Land Is Shaped by Weather and Climate

Norton D. Strommen, chief meteorologist, and Richard C. McArdle,
remote sensing coordinator,
World Agricultural Outlook Board

Farmers in the Midwest send hay to drought-stricken farmers in the Southeast. The South and Pacific Northwest assume preeminence as U.S. timber regions. New York City receives lettuce from California's Imperial Valley year-round. Iowa, Illinois, and Indiana produce record crops of corn and soybeans. Cherries and other fruit from the shores of Lake Michigan help to support the State's economy. Wheat from the Dakotas, cotton from the South and Southwest, and citrus from Florida provide food and fiber for the Nation.

Seemingly unrelated, these happenings share a common factor: Climate. It shapes the landscape, through wind, water, and temperature. It creates soil, delineates native vegetation, and ultimately determines land use for agriculture and forestry.

Weather and Climate

The average of weather conditions in a given location is its climate. Weather and climate result from complex interactions of forces in, around, and within the earth.

The sun provides the basic energy for the changes in weather and climate. Solar heat varies with latitude; the tilt of the earth—its angle to the sun—determines how much energy will strike the earth's surface. The heating between land and water results in patterns of air circulation. Conditions in the atmosphere and its "drag" as the earth spins on its axis also influence weather and climate. Surface mountains block or deflect moving air masses, and large bodies of water modify the climate of adjacent land areas.

Climate is particularly noticeable at times of crisis. The widespread, and generally severe droughts in the southeast in 1983 and 1986 were reminiscent of the catastrophic 1930's drought in the Midwest and Great Plains. Water availability frequently determines what forest cover will dominate an area. Except for cottonwood and willow along rivers and creek bottoms, the eastern edge of the treeless "great plains" extending from the Missouri and Mississippi Rivers to the Rocky Mountains is marked by a 20-inch rainfall. Rapid growth of conifers in the South and the Pacific Northwest is aided by mild weather and plentiful well-distributed rainfall,

During the 1986 drought in the Southeast, a Georgia farmer indicates the height his 2-month-old soybean plants would be in a year of normal rainfall. (June Davidek, OGPA, 0886D962-7)

especially in the Northwest between the Pacific Ocean and the Cascades.

Irrigation, sunny days, and favorable temperatures make central and southern California valleys bountiful with fruit and vegetables for urban markets.

Deep, rich soils, the result of wind and water deposition over thousands of years plus dependable summer rainfall and hot weather, make the Corn Belt one of the richest agricultural areas in the world.

Oceans and seas moderate climate. The same is true, to a lesser extent, of large inland bodies of water. Wheat, a grass, is an obvious choice for those regions where scanty rainfall resulted in a native vegetative cover marked by a seemingly endless sea of grasslands. Cotton is also "choosy," preferring the warmth of the Southwest for best output.

Solar Energy, Water, and Wind

The variety of land forms across the Nation is the result of past climates. The principal climate forces that shape the earth's surface, determine the natural environment, and ultimately influence the activities of human beings are temperature, water, and wind. Duststorms, eroded fields, and sediment-clogged streams and rivers attest to their power. The role of weather and climate in forming soils and landforms is slow, but, on occasion, a major weather event can cause significant changes in hours.

Solar energy in the dry climate zones acts to degrade the rocks of mountains through deferential heating. The fracturing of the rocks and the buildup of tallus piles at the base of the rugged mountain peaks is mostly free of vegetation. The lack of frequent rain and flooding leaves weathered pieces of rocks where they fall, and the transformation into soils takes eons of time. The conversion of parent rocks into usable soils is much more rapid in the more humid climates. When the surface is flat and erosion slow, deep rich soils may form such as seen in the midwestern States. With a greater frequency of flooding the water is more effective in removal of the finer particles from their original point of origin.

The largest rivers daily carry millions of tons of soil particles from the mountains and higher plains to the sea. The Mississippi Delta is an example of how the continent can be extended into the sea as river-carried sediment is deposited when the flow becomes slower. In the case of the Mississippi Delta, without the large levees and constant dredging, the outlet of the Mississippi would likely have shifted to a new location during one of the recent major floods. Much of the city of New Orleans protected by the levees is now several feet lower than the river during periods of flooding and would be inundated should the levees fail.

In China, the centuries of building higher levees and lack of dredging has resulted in the Yellow River bottom actually being several meters above the surrounding terrain. Without the levees, even low levels of stream flow would flood the rich agricultural lands and destroy cities that have occupied their current location for centuries.

Wind, while not as effective as solar energy, rain, and freezing in determining landscape, can at times be very effective in moving soils. With the aid of satellites, clouds of dust, originating in the western United States have been tracked over the Nation and out over the mid-Atlantic. Similar clouds of dust originating in the Sahara have been tracked across the Atlantic into Brazil. Powerful winds associated with blizzards and hurricanes can change the local landscapes as well as more localized winds, known as chinooks or foehns, and most common winds along the base of the western mountains.

Climate also is directly associated with soil fertility. While rainfall provides lifegiving moisture for plants, the same moisture percolating through the soil can leach out many of the necessary minerals and other nutrients.

Working with Climate

What can be done in existing cropping areas when climate changes, for example, or weather during the growing season becomes more variable, with greater extremes of temperature and rainfall? How can agriculture be extended into those regions not favored by a beneficent climate as may be required when additional land is needed to feed and clothe rapidly growing populations?

Although objectives differ, the problems are similar. Basically, there are two ways to deal directly with changed climate conditions: (1) modify the climate, or mitigate its effects through artificial means, and (2) adapt plants, animals, and cultivation practices to meet the new conditions.

Modifying Climate. Obviously, any changes to be made in the environment or in adaptation must consider economic realities. In theory, agriculture could be carried on in vast greenhouses, avoiding the problems created by the vagaries of weather and climate. Such a visionary approach may be taken at some time in the future. Indeed many high-value specialty crops, fruits, and vegetables are now growing commercially under glass and plastic. But in practice, and in the immediate present, the cost of moving large segments of agriculture indoors, particularly those crops that are cultivated extensively, that is, crops like wheat which require large acreages for commercial production, is prohibitive.

Inadvertent modifications of climate on a global or continental scale may well occur through unwise diversion of major rivers or ocean currents, or through continued contamination of the atmosphere with particulates and other substances. For the present intentional modification of climate, or directly ameliorating any adverse effects, must be directed to subcontinental regions and, more likely, to localized areas and to specific sites.

Adapting to Climate. Attempts to modify climate on regional and subregional scales include the ambitious Great Plains shelterbelt program of the 1930's. While the regional effects of the program are not clear, individual windbreaks have protected fields and farm buildings. Construction of ponds, intended primarily for conservation and on-farm water supply, also may have influenced climate on a local scale.

Effects of adverse climate and weather can be mitigated through a variety of means. In agriculture, most strategies for humid areas include ways to provide supplemental water to plants and animals during dry periods. In arid and semiarid areas, strategies are focused on ways to provide the water to establish and sustain plant growth.

Irrigation illustrates the complexities of responding directly to mitigate climatic effects. The source of water must be considered first. In some areas, water trapped in underground aquifers can be pumped to the surface for irrigation. Pumped water from the Ogalalla aquifer in eastern Colorado and western Nebraska, for example, has expanded corn production using center-pivot irrigation systems.

For the most part, surface water is used for irrigation, with rainfall being intercepted in reservoirs for later distribution, or taken from streams and rivers. The snowpack at higher elevations in the mountain also serves as a reservoir. The melting snow in the Rocky Mountains and Sierras provides much water which finds its way into irrigation systems throughout the West.

Even in rainfall deficient areas, moisture can be harvested using either simple methods, such as digging trenches and pits, or more complex systems, such as spreading plastic sheeting to catch the evening dew and the occasional trace rainfall. Eventually, desalting brackish water and seawater may become an economical source of water for agriculture.

To adjust to changing climate conditions and adverse weather, farmers or ranchers can modify their operations in several ways. For example, they can select species and varieties that are drought or temperature tolerant, or have a shorter growing season. They can change the timing of their operations, planting, cultivating or harvesting to take advantage of, or avoid; specific weather and climate conditions. They can institute tillage practices to increase soil moisture, or reduce moisture loss through runoff, surface evaporation, and percolation to deeper levels. Such tillage practices include "no tillage," chisel plowing, deep plowing, and discing after rain.

What is Ahead?

Urbanization has measurably modified the local climate, best illustrated by the "urban heat island" and its effect on the basic climate elements. The urban heat island is documented by higher temperatures, higher particulate matter or dust levels, lower wind velocities and more seasonally variable precipitation patterns.

Industrialization also may be modifying the larger scale climate features through increased levels of CO_2 released into the atmosphere. Carbon dioxide alters the rate of heat loss back into space. This is referred to as the greenhouse effect or the ability of the atmosphere to permit short wave solar energy to pass through but limit the loss of long wave earth radiation from escaping into space.

Recent research has shown that other trace gases such as methane may be equally as important as CO_2 in contributing to the greenhouse warming expected globally in the decades ahead. Rice paddies are a major source of methane gas, and rice acreage increased until recent years. Termites also release methane to the atmosphere.

While irrigation has been a major factor in overcoming weather and climate constraints on agriculture, further development of drought-tolerant grains and other food crops will help to stabilize production in areas where variability in weather is increasing.

Today's researchers now are able to understand and measure the effect of people and their activities on climate and changing weather patterns. This knowledge is basic to the future of America's agricultural productivity.

New Directions

Part VII

Alternative Agriculture

Kenneth A. Cook,
senior associate, The Conservation Foundation

Not many people involved in American agriculture 10 years ago would have predicted that the 1980's would bring chronic commodity surpluses, record government program costs and land-idling measures, severe drops in farmland values, poor export performance, low prices for farm goods, or many of the other disturbing problems now facing U.S. farmers. A great deal has changed since the export boom of the 1970's; quite a few crystal balls have turned out to be cracked. One of the consequences is that many farmers are taking a different approach.

Alternative Farming Systems

Practitioners of alternative agriculture—variously called "organic farming," "sustainable agriculture," "low-input farming," or "regenerative agriculture"—are more likely to be realists than purists when it comes to the use of agricultural chemicals. But they definitely reject the conventional wisdom that guided the use of fertilizer and pesticide for most of the 1950's, 1960's, and 1970's: "If a little is good, a lot is better." Today many farmers feel that principle is as outdated as planting fence row to fence row. And alternative agriculture has in its ranks many family-sized farm operations.

So what is alternative agriculture? The term has no precise meaning. It can describe a wide range of farming styles and practices. But most alternative farming systems share several characteristics.

Use of Fewer Manufactured Inputs. First, alternative agriculture connotes farming systems which economize on the use of manufactured inputs, notably fertilizers and pesticides, but also chemicals used to prevent livestock diseases or promote growth. Some proponents of alternative agriculture strive to eliminate those inputs altogether, and try instead to devise farming systems which supply plant nutrients and control weeds, insects, or disease through other means. For most practitioners however, the emphasis is on minimizing the use of agricultural chemicals without drastically reducing crop yields or livestock production—a goal shared with a great many "conventional" farmers who are worried about production costs given today's paper thin profit margins.

Dick Thompson, a Boon, Iowa, farmer, examines yellow blossom sweet clover that makes up part of his legume-grass pasture mix. Instead of using purchased N fertilizers, he plows down legume pastures and legumes overseeded into row crops to supply nitrogen for future crops. (Photo courtesy of The New Farm)

Environmental Concern. Economics may be the overriding motive behind alternative farming today, but concern about soil and water conservation, wildlife, and the environment is not far behind. Alternative farming systems tend to be very effective in controlling erosion, runoff, and pollution of surface water and ground water. There are two main reasons why. First, these systems tend to be built around crop rotations which include small grains or sod-based crops, which provide more soil protection than most conventional cash grain systems, in which corn or soybeans are grown continuously. Second, alternative systems for all crops use less fertilizer and pesticides, lessening the chances that chemicals will have unintended negative side effects, such as polluting ground water.

Health Concern. One final motivation for alternative agriculture is concern about human health. Farmers who worry about the effects agricultural chemicals may have on their health or that of their family and neighbors are looking for ways to control weeds, insects or disease, or to nourish their crops while reducing their use of chemicals.

Another important health dimension is a growing interest among consumers for foods free of additives or pesticide residues. ''Organic'' or ''natural'' foods represent a multibillion dollar industry that has expanded from health food stores to the aisles of most supermarkets and a growing number of restaurants. While the quality and purity specifications for such foods are not uniform, many farmers are producing fruits, vegetables, or grain and livestock products for this expanding "specialty" market.

Other Goals. Some proponents of alternative agriculture attach importance to other goals. Diversified, low-input, labor- intensive agriculture is seen by some as the key to preserving the family farm. Other students of alternative farming stress localized food production and direct marketing as the best formula for keeping farmers on the land at the city's edge.

Perhaps the most important applications of alternative agriculture lie in the developing world. For the hundreds of millions of poor peasant farmers in those countries, farming systems that use farm sources of fertilizer (from legumes or manures), native crops, and limited amounts of chemicals to control pests may make more sense—economically, socially, and environmentally—than capital-intensive, highly mechanized agriculture.

Effects of Alternative Farming Systems

What does alternative agriculture mean in practical terms? Patrick J. Madden professor of agricultural economics at the Pennsylvania State University is one of a growing number of researchers studying what may happen when farmers "go organic." Madden and his colleague, Stephen Dabbert, found five "effects" that can influence profits significantly as farmers shift from conventional systems, with heavy use of chemicals, to an alternative system using manure and cropping systems which include pasture, hay, and small grains grown in rotation with corn or soybeans. Their findings apply most directly to crop and livestock operations but are relevant for many types of farming enterprises.

Rotation Adjustment. Alternative farming systems rely heavily on crop rotations to disrupt the reproductive cycles of weeds, insects, and diseases. For the many farmers who have mixed crop and livestock operations—dairy farmers, for example—such rotations are already in place; a shift toward less chemical use on their crops may entail modest changes in farming practices. And their profits may remain the same or may even increase as input costs are lowered. Farmers who produce cash grains exclusively, however, may experience sharp reductions in profits in the first years of organic production, as fields of cash crops like corn and soybeans are partially replaced with alfalfa, clover, or other crops.

Biological. These effects were first described in the Department of Agriculture's landmark 1980 *Report and Recommendations on Organic Farming*. The report observed, "farmers who had previously farmed conventionally, reported that crop yields were often markedly reduced during the first several years following the shift from chemical to organic farming. During this transition severe weed infestations often occurred and crops were sometimes difficult to establish. Occasionally the crops showed symptoms of nutrient deficiency. Farmers said after the third or fourth year, as the rotations became established, yields began to increase and eventually equal the yields they had obtained (using agriculture chemicals).'' Madden and Dabbert point out that it may take several years to establish ''populations of biological pest control organisms. . . especially following a long history of chemical applications that have eliminated many of the natural predators (such as specific types of insects, mites, nematodes or bacteria) and other beneficial forms of life such as earthworms and birds.'' In most cases, therefore, it is important for farmers to make a gradual transition to alternative farming, experimenting with a few fields, not the whole farm, and reducing chemical use in phases rather than going ''cold turkey.''

Some farmers experience no major negative biological effects during the transition. And most studies of alternative farming systems show reduced input costs, which can partially offset income loss caused by reduced yields.

Commodity Prices. For many crop and livestock farmers the price effect will be minimal, since organically grown commodities will be sold through conventional channels at prevailing prices. Organically grown fruit, vegetables, and livestock may bring a somewhat higher price if they can be sold to a specialized market. On the other hand, as Madden and Dabbert point out, insect or disease damage to organic produce may reduce its grade and its price.

''Learning.'' Some producers can adopt low input systems with little difficulty. However, ''where the organic technology is complex and risky and the farmer is inexperienced,'' Madden and Dabbert state ''the learning impact on profits can be formidable.'' Again, a gradual transition with careful planning is critical. It may take time, for example, to develop the combination of mechanical cultivation techniques and rotation patterns required to control weeds. The advice of other farmers who have tried similar approaches can be invaluable. Extension specialists or researchers also may help identify—and avoid—costly problems.

Perennial. The final effect Madden and Dabbert call ''perennial''—how an organic farm's profits compare to those of a conventional farm after a successful transition. Does the final mix of crop and livestock products use farm resources more efficiently and profitably than would be the case under conventional management?

Farm Program Benefits. Farmers who include pasture, hay, or other nonprogram crops in their rotations usually sacrifice ''base acres'' compared to farmers who keep most of their land in cash grains. For some producers, ''going organic'' may mean a reduction in farm program benefits. To some extent, the 1985 Farm Bill changed the rules of the game for producers who crop highly erodible land. Crop rotations may be the most feasible way to keep highly erodible land in production and still meet the soil conservation requirements of the "sodbuster policy" and "conservation compliance." Congress also included in the 1985 Farm Bill the "Agriculture Productivity Act," which authorized more research and information efforts on alternative agriculture.

Information Sources

New policies to save soil and protect the environment, advances in integrated pest management, greater appreciation of the role of natural predators in pest control, innovative tillage practices, such as "ridge till," pressure to control production costs at the farm level, commodity surpluses at the national level, and other developments call for "rewriting the performance specifications for U.S. agriculture," according to Charles Benbrook, an economist who heads the National Research Council's Board On Agriculture. As a measure of the growing interest the "agriculture establishment" is taking in alternative agriculture, the Board will soon release a report on the status of low input farming with recommendations on research, policy changes, and better ways to provide farmers with information about alternative farming systems.

The Institute for Alternative Agriculture located at 9200 Edmonston Road, Suite 117, Greenbelt, MD., 20770 is a useful source for information. *New Farm Magazine* published by Rodale Press in Emmaus, PA., provides information on a wide range of topics in alternative agriculture, including practical advice on farming.

New Challenges of Farmland Conservation

Ralph Grossi, president, American Farmland Trust,
Washington, DC

The challenge is twofold: to save topsoil *and* prime farmland. Allowing our best lands to be paved over would result in using highly erodible land to meet future production needs. Allowing that marginal land to be ruined by erosion would someday require drastic measures to save every last acre of our prime farmland.

1985 Farm Bill

The conservation reserve and sodbuster provisions of the 1985 farm bill are aimed at preventing erosion on our worst farmland. This landmark effort is based on several important principles that also apply to meeting the challenge of conserving our best land: (1) target conservation efforts for maximum efficiency; (2) eliminate subsidies that work at cross purposes with conservation goals; and (3) offer incentives that encourage conservation.

Targeting Urban Fringe Farmland

The Conservation Reserve Program focuses on that fraction of U.S. cropland that is most highly erodible. Cropland soil loss will almost be halved by removal of only 6 percent of our most erosive cropland from production.

The American Farmland Trust (AFT) has begun to pinpoint our most productive farmland faced with the greatest risk of conversion to nonagricultural use. In a new study of U.S. farmland that relates its productivity to geography, AFT found that at least a third of all agricultural production, measured by gross sales, occurs on land close to the most rapidly growing metropolitan areas.

High Productivity. The most recent agriculture and population census data indicates that almost 30 percent of U.S. agricultural production occurs on only 14 percent of farmland located in the 372 counties inside or adjacent to Standard Metropolitan Statistical Areas, and among the top 20 percent in agricultural sales in their respective States. The productivity (sales per acre) of this urban fringe farmland is 2 1/2 times that of all other U.S. farmland, partly because fruit and vegetable production was concentrated near cities, but mostly because the cities began as farm market centers that grew up in the midst of this most fertile land.

Population Threat. Our dependence

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Lettuce is harvested near Salinas, California. About a third of U.S. agricultural production (measured by gross sales) comes from the 14 percent of farmland near metropolitan areas. (USDA, 1080X1324-28A)

on farming in the shadow of suburbia is a compelling reason to conserve farmland on the urban fringe when population trends are considered. Between 1970 and 1980, the population of the 372 agricultural-metropolitan counties grew 20 percent, twice as fast on the average as all other counties, accounting for one-third of the total increase in U.S. population. A continuation of this trend could result in the displacement of one third of U.S. farm production unless steps are taken to assure that growth is accommodated on less productive land.

"Production Reserves" Needed. The Nation should designate a long-term "*production reserve*" composed of its best urban fringe farmland, similar to the conservation reserve established for our worst erodible land. All government levels should cooperate to find mechanisms to keep this land in agricultural production, applying other lessons of the 1985 farm bill.

Eliminating Subsidies

The sodbuster provision denies Federal farm payments to producers who break new highly erodible ground. This same principle applied to keep our prime urban fringe farmland in agriculture would result in closer scrutiny of government subsidies in the development of our "production reserve" land.

These subsidies range from direct expenditures on highways and sewers to income and property tax systems that pass along part of the cost of new development to the public. Adjusting or eliminating them, so that public expenditures and public conservation policy are consistent, is just as necessary to the establishment of a "production reserve" as it is to the conservation reserve. Whether it is subsidized sodbusting or farmland conversion, the cost of conservation is increased.

Every level of government now provides subsidies and should cooperate in their adjustment. A good place for the Federal Government to start would be further strengthening of the Farmland Protection Policy Act. It asks agencies to find alternatives to government-sponsored or -funded construction projects that consume our best farmland; they ought to be compelled to do so. So should State agencies, following the example of Illinois, whose farmland policy act has saved taxpayers millions of dollars as well as thousands of acres of farmland. Local governments would do well to take a close look at the comparative costs of sprawl and compact development, and with state cooperation adjust property taxes accordingly. Then, if we really want to tackle subsidies, phasing out Federal income tax deductions for mortgage interest paid on new houses built on prime farmland in the "production reserve" might be considered.

Offering Incentives

Eliminating subsidies to indiscriminate development would save taxpayers money and help take the pressure off critical urban fringe farmland. But it would not by itself create a "production reserve." For that, positive incentives are needed, just as they were for the establishment of the conservation reserve. In the case of the conservation reserve, the incentive is an annual payment for idling highly erodible land, compensation for lost production. For our "production reserve," it must be compensation for lost urban development opportunity.

State Programs. A half dozen States now have programs to provide this kind of compensation, giving farmers a conservation alternative to selling off the family farm. Many more States and localities could justify the expense of doing so, if they factored in the economic and environmental benefits of agriculture—especially on the fringe of urban areas where most voters live—and if they took advantage of the opportunity to recoup costs by eliminating inappropriate development subsidies.

Fair Compensation. The incentive systems developed by States should be based on a few key principles: Compensation should be fair to landowners and affordable to the public; neither windfalls nor wipeouts should be tolerated. Every landowner who would have a realistic chance of selling farmland to a developer should have a shot at selling "development rights" to the public instead. (An alternative would be to increase the current tax deduction allowed for voluntary donations of these rights, enabling farmers to recover their equity over time.) But the price should not be artificially inflated by subsidies—the public should not be asked to pay for conservation twice. And just as there is competition in the land market, so too should there be competition among local landowners for the opportunity to sell "development rights"; Maryland has used such a system to conserve more farmland at a lower price than any other State.

Finally, the public investment in the "production reserve" should be protected by appropriate local regulations, designed to prevent conflicts between agricultural and nonfarm land uses by keeping residential density low within the reserve.

The Ultimate Challenge

For all who care about the land that sustains us, the ultimate challenge is to make agriculture more profitable to the farmer—who now receives less than 30 cents of the consumer's food dollar. The more farmers earn from cultivating the land, the more they will be able to resist subdividing it. Our "production reserve," the best land next to the biggest markets, will offer them the opportunity to do that.

Locating New Ways To Generate Farm Dollars

Jane M. Ross, public affairs specialist, Office of Grants and Program Systems, Cooperative State Research System

A priority of the recently established Office of Grants and Program Systems (OGPS) within the Cooperative State Research Service, U.S. Department of Agriculture (USDA), is to look at new ways for farmers to use their land. Work there focuses on four complex and diverse areas: industrial materials, aquaculture, small-scale agriculture, and low-input agriculture. Specific projects deal with crops as different as okra, crawfish, and guayule. The goal is to provide alternative opportunities for farmers in cooperation with the private sector and other USDA and State agencies.

Assisting OGPS in providing alternatives for U.S. farmers are the Agricultural Research Service, Forest Service, Economic Research Service, and cooperating State agricultural experiment stations for research; and, for education, the Cooperative Extension Service and the National Agricultural Library.

Finding New Uses

Finding novel or alternative uses for farmers to work the land is not new, but it is even more important today because of intense international competition and changing consumption patterns.

Global economic changes of the past 5 years have upset the U.S. agricultural and forestry export and import trade and caused as much as a $22 billion drop in U.S. sales of these products abroad from 1981 to 1985. This resulted in reduced land values and financial hardships for many farmers.

Diversification many see as agriculture's best response to this situation—diversification into both food and nonfood production areas, and away from sole emphasis on a few major crops. OGPS works to provide farmers with options, ranging from farm-grown fish to newsprint, to produce cash crops leading to developing new markets for domestic agricultural products.

OGPS projects are usually 2–4 years, with public-private partnerships established through USDA cooperative agreements. The agency arranges demonstration projects to help sell commercial participants on promising results from research. Capitalizing on

Kenaf, which can go from a seed to a 10-foot-tall plant in less than 4 months, is harvested in Texas. After processing, the fiber becomes the morning newspaper. (Dan Kugler, CSRS)

the research and development of the Agricultural Research Service, and State agricultural experiment stations, projects build new, emerging agricultural industries in the private sector.

The Federal Government in demonstration projects recognizes that the processing and market sector does not necessarily have a vested interest in agriculture. A third party is often needed to develop mutual interests. Long-term investment strategies in new enterprises can be encouraged by partnerships between the private and the public sectors. The private sector must identify the market, while the public sector provides technical expertise, seed money, and the linkage of production, processing, and marketing sectors. Clearing regulatory roadblocks is an important OGPS function.

The Office of Critical Agricultural Materials

Established in 1984 by PL98-284, this office seeks to develop new domestic sources of materials essential for the Nation's economy and in the process open opportunities for producers here. Many of these materials currently are imported, and domestic production could ease U.S. dependence on foreign sources.

Four domestically grown crops are most promising for commercial development. Crop demonstration projects are underway for two of them—guayule, a shrub, and kenaf, a plant. For crambe and winter rapeseed, oilseeds which produce high erucic acid, project plans are being developed.

Department of Defense (DoD)/USDA Guayule Agreement. A 27-month Joint Guayule Domestic Rubber Project agreement was signed in 1986. Ground will be broken in 1987 on a prototype plant in Arizona operated by The Firestone Tire & Rubber Company. The goal is to produce about 50 tons of rubber for test and evaluation to see if the rubber meets DoD's standards of heat resistance and durability. DoD has agreed to purchase up to 20 percent of its annual tire-rubber requirements if the process works.

USDA will use DoD funds for technical assistance and cooperative agreements with universities and others to strengthen research and development efforts and to explore alternative market opportunities. At the same time, USDA and the State agricultural experiment stations will provide additional money for guayule research.

Kenaf Demonstration Project. This project was begun in 1986 with a cooperative agreement between CSRS and Kenaf International. The objective is to demonstrate the economic viability of kenaf as a fiber of choice for use in manufacturing newsprint—a commodity imported at a cost of $3 billion annually. The use of this crop will not replace wood chips as the major raw material source, but in some markets there are price and quality advantages. For example, it uses less ink, produces whiter paper, and requires less energy to process. The growing area for kenaf is across the southern tier of the United States.

Work in 1987 includes commercial paper machine and pressroom runs and evaluations of the kenaf newsprint system from seed production to daily newspaper. Large-scale kenaf farming for newsprint manufacture is not expected until the 1989 or 1990 growing seasons. In the meantime, work will focus on converting existing mills, evaluating a second non-competing market in the felt industry, planting more acreages in selected States improving harvest and fiber handling methods, and developing public and private partnerships towards the commercialization of kenaf.

High Erucic Acid From Crambe and Winter Rapeseed Industrial Oils. A planning conference sponsored by USDA, Iowa State University, Kansas State University, and the University of Missouri concluded that current erucic acid oil markets rely on foreign sources, but that production technology is sufficient for establishing a domestic production system.

High erucic acid uses include its inclusion in nylon products for gears, fasteners, and tubing and in lubricants. Government and private industry are identifying the most promising markets to explore.

The Office of Aquaculture

Established by the Agriculture and Food Act of 1980 and the Food Security Act of 1985, this Office is USDA's focal point for coordinating the development of aquaculture with 12 USDA agencies and many outside USDA.

Production. The U.S. aquaculture industry is growing rapidly. The U.S. trade deficit in fish and shellfish continues to climb as does per capita consumption of aquatic foods. In 1985, the net deficit for edible fish products was $3 billion. The total U.S. trade deficit in fish products, including those used for both edible and industrial needs, was $8.6 billion.

OGPS recognizes the need for a strong domestic aquaculture industry to increase domestic production of fish and shellfish and reduce U.S. dependency on foreign suppliers. The industry offers, as well, economic benefits in rural America as a source of alternative crops and the creation of jobs.

Centers. By acts passed in 1980 and 1985, Congress authorized the establishment of four aquaculture research, development, and demonstration centers in association with colleges and universities, State departments of agriculture, Federal facilities, and nonprofit private research institutions. The centers are located in Hawaii, Massachusetts, Mississippi, and Washington.

Hybrid/Striped Bass (HSB) Demonstration Project. HSB is intended to demonstrate the economic viability of HSB farming as a crop alternative for east coast farmers and watermen. Midwest production also is possible.

East coast populations of striped bass have declined and most coastal States have prohibited fishing for them. The seafood industry is seeking alternative sources, and farmers are seeking production alternatives. Producing these fish would fill a market void, and a premium price could be demanded for the product.

A small, ongoing research project on the Eastern Shore of Maryland is to be expanded to a production level demonstration farm for HSB, using the expertise of Federal, State, university, and private interests. Approximately 30 acres, 24 of which will be under water, will produce at least 60,000 pounds of fish.

The Office for Small-Scale Agriculture

This Office, established in 1986 by the Secretary of Agriculture, improves the flow of information on small-scale farming to agricultural producers and consumers. The Census Bureau indicates that the number of small farms increased 17 percent during a recent 5-year period and that many small farms are operated by part-time farmers who produce diverse agricultural products including vegetables, fruits, nursery plants, honey, and livestock.

Small farms have increased in number and importance as a result of consumers' increased preference for fresh and locally grown farm produce, as well as because of the increase in direct marketing including local retail farm markets.

The Office publishes a bimonthly newsletter on small-scale farming systems for researchers and Extension personnel, assembles information on USDA research and education of benefit to small-scale agriculture, and monitors and conducts regional and national conferences on small-scale agriculture.

Low-Input Agriculture

This approach to farming encourages greater use of systems that provide special benefits; for example, use of nitrogen-fixing species and pest control that depends heavily on using crop rotation, spacial diversity of plants, and cover crops. Fertilizer and pesticide use is still necessary, but at reduced levels. With lower commodity prices, farmers must find ways to reduce input costs and enhance net returns rather than use technologies that emphasize larger yields.

Current Issues Link Agricultural and Environmental Interests

Hal Hiemstra, president,
American Land Resource Association,
Washington, DC

Stop and ask an Agriculture Committee member in the halls of Congress to name major national environmental groups. The member could probably identify dozens—the Sierra Club, the Audubon Society, the Natural Resources Defense Council, and many more. Next, ask what major issues these environmental groups typically focus on. A few years ago, the member's response would probably be the conventional environmental areas of air and water pollution and natural habitat protection. Now, however, *agricultural land policy* might be as likely an answer as protection of the snail darter.

Beginning of Change

William K. Reilly, president of the Conservation Foundation, recalls a 1982 meeting between a group of conservationists and USDA officials. Concluding the meeting, Assistant Secretary John Crowell turned to the group and said, "The need as we see it is to downsize the U.S. agricultural production machine. If you conservationists can help us do it in such a way that we reduce agricultural subsidies and also benefit the environment, we have an opportunity to cooperate."

This was typical of the exchanges between the conservation and environmental communities in 1982. By late 1983, agricultural policy and its impact on land management had become a rallying point for many of the Nation's mainstream environmental, conservation, and natural resource groups. Following successful coalition building in the late 1970's on a wide variety of environmental issues, these same public interest groups turned their attention to the Nation's farm policy and the upcoming 1985 Food Security Act, otherwise known as the farm bill.

Environmentalists Support 1985 Farm Bill

Interest from environmentalists in the 1985 farm bill debates was driven by obvious linkages between overproduction—encouraged by massive farm support programs—and poor management of much of our country's most erosive agricultural land. Their interest was further fueled by an emerging awareness that nonpoint source pollution—primarily from agricultural runoff—was contributing to the Nation's inability to achieve fishable and swimmable water quality standards.

For years, representatives of environmental groups such as the Natural Resources Defense Council had been urging the adoption of conservation "cross-compliance." The argument was that by conditioning farm support upon the development and implementation of conservation plans, Federal farm support dollars could be saved and significant reductions in erosion rates would be achieved. Those "radical" arguments went largely unheard until the Nation's economic farm crisis and skyrocketing Federal support payments opened the door for serious discussion about new ways to control Federal farm spending.

As the issues of conservation and the Nation's farm debt crisis became the dominant agricultural themes in 1983 and 1984, environmental, conservation, and natural resource groups seized the opportunity to inject conservation planning into farm policy debates. Representatives of these groups knew that collectively they could capitalize on the emerging budget-cutting, policymaking atmosphere. Congress appeared ready to reduce the costs of farm support programs, to provide financially pressed farmers with new financing options, and to remove millions of highly erosive acres from production.

Conservation Coalition Formed

Informal efforts to organize a "Conservation Coalition" were begun in 1983. By 1984, members of well over 20 national environmental, wildlife, conservation, legal defense, farmland, forestry, and agricultural groups had begun developing a unified conservation agenda. By early 1985, the Conservation Coalition was meeting regularly and cooperatively advancing their unified conservation positions.

Conservation Legislation Emerges. Using skills honed in earlier environmental battles, Coalition members pressed their conservation agenda before congressional agricultural committee members and staff. The strongest conservation legislation since the 1930's was the result. Included was a 45-million acre Conservation Reserve Program (CRP), new swampbuster and sodbuster provisions, and conservation compliance requirements for all highly erodible cropland in the country.

Responding to the need to provide alternate financing options for America's farmers, the Conservation Coalition also supported the "farm debt restructure and conservation set-aside" provision of the 1985 farm bill.

Agricultural Land Policy on Agenda. The successes of the Conservation Coalition have changed forever the way in which farm policy will be decided in this country. Members of the conservation community, particularly the environmental groups, now add soil conservation and agricultural land policy to their permanent legislative agendas. The Sierra Club, for example, even hired staff to address agricultural land policy issues.

Environmental Concerns

Overproduction. To the environmental community, wheat and corn surpluses do more than signal economic problems for the farm sector. Surpluses also signal the overuse of our agricultural land resources. In turn, overused land resources signal long-term environmental problems. Robert Healy, Thomas Waddell, and Kenneth A. Cook, all of the Conservation Foundation, report that 28 percent of the fertilizer and 40 percent of the pesticides used in this country in 1986 went for the production of surplus corn and wheat. Environmental groups are asking the obvious question, Just where do all those farm chemicals end up?

Agricultural Sources of Pollution. Increased and more technically accurate monitoring of ground water continues to show direct linkages between agricultural chemical use and ground water contamination. Such direct linkages will keep ground water pollution and Federal agricultural policy high on the environmental agenda.

Similarly, agricultural nonpoint source pollution control continues to gain attention within the environmental community. The Environmental Protection Agency and numerous national studies have shown that our Nation's surface water quality will not improve significantly unless agricultural sources of pollution are treated. Because agricultural nonpoint source pollution is best treated by modifying farm management practices, environmentalists will likely push for increased technical assistance to farmers and increased monitoring for noncompliance.

Environmentalists have targeted support for funding of the Agricultural Productivity Act (APA) to encourage the increased adoption of low-chemical agriculture in 1987. Passed as part of the 1985 farm bill, the APA encourages research into, and support for, new and alternative agricultural production systems.

Wetland Drainage. The environmental and conservation communities also will continue to combat wetland drainage for agricultural purposes. Wetland drainage has resulted in significant losses of fish and wildlife habitat and aquifer recharge areas. Despite reduced Federal farm program incentives to drain wetlands, this natural resource continues to be lost at annual rates measured in the hundreds of thousands of acres. To curb the continued loss of wetlands, members of the Conservation Coalition used the sodbuster concept to include wetland drainage provisions in the 1985 farm bill.

Supporting Conservation Legislation

A key question now facing environmentalists is whether the Federal Government will seriously carry out and defend the numerous conservation provisions of the 1985 farm bill. Environmental groups have indicated that they will vigorously oppose actions to repeal or dilute conservation provisions of this bill.

Conservationists pushed hard for the rapid development of interim CRP rules, and closely monitor the program's success. Coalition members rigorously support long-term funding of the program and also will likely support a 20-million-acre expansion of its original goal.

Considering CRP's success, environmental groups are beginning to ask whether Federal acreage reduction targets could be linked to other conservation objectives and used to solve existing environmental problems. Ground-water pollution control, for example, might be a logical "next step" in linking farm surplus reductions with environmental pollution control.

Future Cooperation

Environmental groups continue to pose new farm policy questions and seek new ways to adjust farm policy so that it will benefit both the farmer and the environment. Although farm and environmental groups may have found themselves on opposite sides of the fence in the past, the gates are now open and a new era of cooperation is underway.

New Horizons on Our American Land

Philip M. Raup, professor emeritus, Department of Agricultural and Applied Economics,
University of Minnesota, St. Paul

U.S. cropland harvested from 1911 to 1920 averaged 336 million acres annually, almost exactly equaled by the annual average of 334 million acres harvested during 1976-1985. During the intervening 65 years no increase occurred in total cropland acres harvested, yet corn production increased 2.7 times; wheat 2.95 times; and 63 million acres were diverted to soybeans, a crop not reported officially until 1924.

Changes in Cropland Use

Many of the acres harvested in 1976-85, however, were not the same acres harvested in 1911-20. Much shifting took place—declines in the Northeast, in Appalachia, and in the South Atlantic States offset by increases in the Mississippi Delta, the Corn Belt, the Lake States, and in the West. Nor have acres remained a stable unit of measurement. Apart from horticultural crops, virtually no double-cropping was practiced until after World War II. By 1982 more than 12 million acres were double-cropped, principally to wheat and soybeans in the Appalachian, Southeastern, and Delta States.

Other changes were the decline in horses and mules as a source of draft power resulting in oat, hay, and pasture land being converted to soybean production primarily, and the rise of irrigation. The census in 1910 reported 14 million acres irrigated, 20 million in 1930 increasing to 26 million in 1949, and by 1978 50 million acres or 15 percent of harvested cropland. In 1982 about one-fourth of the total value of crop production came from irrigated land.

Interdependence

Increase in Purchased Inputs. In 1910, labor was 53 percent of the total cost of inputs in farm production, land 20 percent, purchased inputs 13 percent, and taxes, interest, and miscellaneous expenses made up the remainder. By 1985 labor had declined to 19 percent of total input cost, land was 23 percent, and purchased inputs increased to 46 percent. The agricultural economy had become dependent on off-farm purchases for just under half of total inputs used in production. This rise in the urban-industrial support base for agriculture encouraged intense use of our agricul-

In 1985, purchased inputs (planters, seed, fertilizer, etc.) represented 46 percent of the cost of farming, up from 13 percent in 1910. (Jay Beavers, OGPA, 0485G337-33A)

tural land. Evidence indicates that this will continue and farming will become increasingly integral to the industrial economy.

A farm is not precisely defined. A canning company in Minnesota buys corn from farmers and packs it in cans. It is classified as an industry. A large feedlot in Kansas buys corn from farmers and "packs" it in beef carcasses. It is classified as a farm, yet its processes are similar to those of the industry, and its direct use of land (space) is just as concentrated. To call one an industry and the other a farm distorts the statistics on farm size and the degree to which production is concentrated in large farms.

Rise in Part-Time Farming. The urban-industrial sector also affects land use in other ways. A major trend since World War II has been the rise of part-time farming. The total off-farm income of farm households exceeded aggregate net farm income in every year from 1976 through 1985. Farm families have diversified, not by including more enterprises within their farm businesses, but by doing off-farm work. Part-time farming is likely to increase. The most stable agricultural regions already are identified by their proximity to nonfarm jobs.

Increase in Forest Land. The 19th century brought with it the decline of agricultural land uses in the Northeast, as industrial and urban jobs drew labor off farms. Much of the land once farmed reverted to forest. Today, the Northeast is the most heavily forested region in the country, with forests occupying 65 percent of the total regional land area. Among the three Lake States, Michigan is the most heavily industrialized and urbanized, but it also has the highest percentage of forested land, 50 percent. Declining real costs of transport and refrigeration have made forestry the preferred land use as regions become highly urbanized and no longer need close-in farm suppliers.

Continuing excess agricultural production may influence other regions to convert cropland to forests. Forest management increasingly reflects noncommercial goals.

Forests as Energy Source. In addition to recreational and rural residential demands hybridization and the promises of biotechnology strengthen the attraction of forests over land in crops. Also, forests produce more energy through photosynthesis than any other land use. Petroleum shortages could renew interest in biological energy sources. If this occurs, forest cropping as a source of fuel-grade alcohols is likely to win over corn or other field crops. Forests as an energy source could experience a rebirth in the 21st century.

Depreciation of Land

An axiom of accounting, law, and economics is that land is nondepreciable, but it can depreciate, in both a physical sense through soil erosion and modern farming practices and in its locational or site value. The opening of the Erie Canal in 1825 depreciated the agricultural lands of the New England States. The process was repeated for the grain lands of Western Europe, when transcontinental railroads opened export markets for the western Corn Belt and Great Plains after the Civil War.

Value of Water Increases. Today's extensive use of fertilizer and irrigation depreciates the relative value of land with favorable soil and climate, particularly land in the Corn Belt. The highest crop yields in Kansas and Nebraska are achieved under irrigation, in the western or drier parts. Early maturing seed varieties and chemical fertilizers are opening up the potential for multiple cropping in the Southeast and Delta States. Soil fertility can be managed in response to prices, markets, and even the public's tolerance of agricultural pollutants.

Modern agriculture with its reliance on fertilizers depreciates the value of land, relative to the value of water. This shift has been prominent since 1950 in the southern Great Plains and in the Southwest, and to a smaller degree in the Southeast and the Pacific Coast States. Half the doubling of irrigated acres from 1949 to 1978 occurred in the Great Plains, primarily based on ground water withdrawal from the Ogallala aquifer in Nebraska, Kansas, and Texas. This has created unstable patterns of land use in those States since recharge of the Ogallala aquifer is very slow and in its southern extension almost nonexistent.

The area coincides closely with the southern Great Plains Dust Bowl of the 1930's. It now supports feedlots and slaughtering plants producing almost half of all the fed beef in the country. This feedlot sector was developed since the severe droughts of 1934–36 and 1954–55. The area has not yet had to cope with the droughts and dust storms of the Great Plains, but it is one of the most environmentally and economically vulnerable areas in the Nation.

Shifting Shares in World Markets. Grain lands depreciated as their ability to command world markets declined. The same technologies reordering the relative values of domestic lands and waters are at work worldwide. Agricultural output increases in Western Europe, India, and China are being achieved on lands with some of the longest records of continuous agricultural use. The newer lands of South America are just beginning to realize their potentials. Improvements in storage, handling, and ocean transport have led to an almost continuous fall in the real cost of intercontinental grain movements for over 100 years. These costs are now at their lowest level in history. For any grain deficit nation, the supply area has become the world.

Research and Technology Base Essential

While the Mississippi-Missouri Valleys no longer have the relative supply-power in world markets that they had from 1880 to 1980, their comparative agricultural land-use advantage has not been lost, but diminished. Its future depends on research and technology, and less and less on its natural endowment.

This support base, in turn, will reflect the institutional structure of agriculture and, indeed, that of the entire economy. Public support for the further developing land-using technologies combined with private incentives for applying this new knowledge is characteristically American. That which can best be done in the public sector receives taxpayers' support. The outstanding example is the system of land-grant colleges, universities, and experiment stations. Those things that could have faltered if assigned to large organizations, whether public or private, have been left to many small proprietary firms. These firms or farms were large enough, however, to afford experimentation and absorb risk while small enough to fail at low social cost. The learning while doing approach has maximized the effectiveness of science and its application.

Structure of Land Ownership Threatened

The heart of this institutional structure has been the diffused pattern of land ownership and control, but control over the land is gradually being concentrated in fewer hands. Land-using firms in some areas are approaching sizes that in industry have led to bureaucratic rigidity and to efforts to control markets. In countries where land ownership has been separated from possession and use, this separation has fostered strife, and its resolution has retarded mobility of labor and capital. Farm tenancy in developing countries has typically been associated with exploitation and political unrest. In developed countries it has more often been associated with rent controls and tenant security legislation that have fostered structural rigidity and soured rural-urban relations.

The financial stress in U.S. agriculture associated with the decline in export markets since 1980 threatens the structure of land ownership. The consolidation of weaker farms into larger units is not the primary danger. The greater threat arises from the prospect that land ownership increasingly may be separated from decision-making regarding land use.

The underlying strength of the managerial structure that has sustained U.S. agriculture has been the association of risk-taking with reward and the opportunity to combine income from labor and capital, thus permitting tradeoffs among savings, consumption, and investment within individual farm households. The result has been an efficient, capital-intensive agriculture, largely free of labor strife, and structured to promote change. What's more, Americans know it works and want it to continue to do so.

A Farm Program With Incentives To Do Good

Katherine Reichelderfer, associate director,
Natural Resource Economics Division,
Economic Research Service

Today's agricultural conservation policy, as embodied in the 1985 Food Security Act, differs in both style and substance from earlier conservation approaches. For the first time, soil conservation objectives are consistent with, but distinctly separate from, programs designed to reduce overproduction of surplus crops.

Under a forerunner approach, the Soil Bank Program of 1956, many farmers received rental payments from the Federal Government in return for retiring land from crop production for up to 10 years. This program removed 28 million acres from production, some of which still remain in forests or grasslands. But no one knew whether the land placed in the Soil Bank was the same land that was the source of the majority of soil erosion problems. Many areas of the country had not had their soils mapped, and the interrelationship of soil type, terrain, and climate with soil erosion rates had not been worked out. The "bank" was open to all, whether or not their soil was eroding at excessive rates, and nobody was penalized for continuing cultivation of highly erodible land.

The current programs focus on lands where a soil erosion problem exists and provide both incentives to conserve soil along with disincentives to abuse our land resource.

Why the New Look?

The change in approach arose mainly from increased recognition that (1) soil conservation and agricultural commodity programs were unintentionally working at cross purposes, and (2) soil erosion problems adversely affect much more than just land productivity. Society pays a price for soil erosion and has a stake in preventing it.

Commodity programs help maintain farm income by guaranteeing a minimum price to farmers who participate. The price support benefits of these programs, which are mainly for food grains, feed grains, and oilseed crops, provide incentives to keep acreage in production of supported crops, but the cultivation of these crops results in higher rates of soil erosion.

At the same time farmers received program incentives which, indirectly, encouraged erosion. Many of them also received government payments to

The Food Security Act of 1985 provides incentives to conserve the land most likely to erode. (Tyler, SCS, IDA-45,382)

adopt soil conservation practices. This inconsistency raised questions. Why pay farmers to encourage erosion and then pay them to reduce erosion? Why provide commodity program benefits to farmers who do not take care of their land to preserve its productivity for future generations? Our agricultural program legislators and the public recognized the need to resolve these inconsistencies.

Something else happened in the early 1980's. Soil erosion became widely recognized as causing more problems off the farm than on it. Eroded soil finds its way into water systems where it diminishes the capacity of reservoirs and lakes. Furthermore, soil eroded from agricultural lands carries fertilizer and pesticide residues into water, severely affecting its quality for recreation, wildlife support, and drinking.

The U.S. Department of Agriculture found that the value of these offsite damages was more than twice the value of onfarm productivity losses from soil erosion. Environmental groups quickly realized this hazard. A strong environmental coalition actively and effectively lobbied for a change in soil conservation policy that would reduce erosion and improve water quality.

Targeting Highly Erodible Land

Instead of encouraging conservation or retirement of land without considering its erodibility, efforts focused on the land with soils most likely to erode.

Fortunately, data and measurement systems now identify highly erodible land. Almost all the Nation's soils have been mapped and the land classified by the kind, extent, and location of soils and other characteristics. The rate at which new soil is formed is known for each soil type in a particular climatic zone. Soil erosion is considered excessive if erosion rates exceed the rate of soil generation.

Over the last two decades, soil scientists developed formulas that predict soil erosion rates based on soil type, slope of the land, rainfall, wind, and other environmental considerations. These formulas, the Universal Soil Loss and Wind Erosion equations, can be applied to any land to determine its erosion potential.

Knowledge of physical, climatic, and management relationships helps in identifying land on which excessive erosion is likely to occur. These lands are targeted by the new conservation policies and programs.

New Conservation Provisions

The soil conservation provisions of the 1985 act apply only to highly erodible land defined in terms of an erodibility index. Any soil with an erodibility index of 8 or more has the potential to erode at least eight times the rate at which it regenerates and is considered highly erodible.

The Soil Conservation Service soil mapping and resource inventories indicate that about 118 million acres of cropland are highly erodible. About 35 million acres of this highly erodible cropland is being managed to prevent excessive erosion. The new conservation provisions focus not only on cropland but on any land that could erode excessively if converted to growing crops.

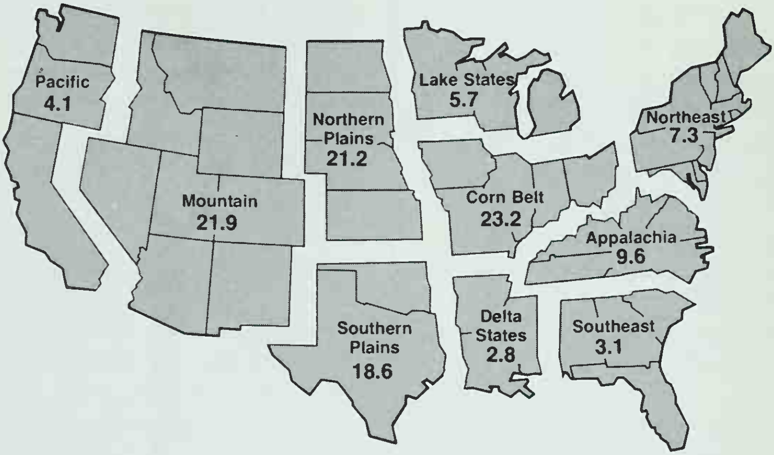
The Conservation Title of the act meets several interrelated objectives:

1. Provides an incentive for farmers to take highly erodible land out of production;
2. Penalizes farmers who continue to cultivate highly erodible land without applying management practices to keep soil from eroding excessively;
3. Prevents highly erodible land and wetlands from coming into crop production; and
4. Assures that commodity programs and conservation programs are consistent.

The Conservation Reserve Program, the Conservation Compliance provision, and the "sodbuster" and "swampbuster" provisions are the instruments for achieving these objectives.

Conservation Reserve Program (CRP). This program assists owners of highly erodible cropland in conserving and improving the soil and water resources of their farms and ranches while reducing production of surplus crops. CRP creates a conservation

Distribution of Highly Erodible Land, by Crop Production Regions (Million acres)



reserve which, by 1990, will contain 40–45 million acres of highly erodible land.

Only highly erodible cropland that has been used for crop production in at least 3 of the last 5 years and is eroding at excessive rates is eligible for placement in the reserve. Owners can bid to enroll such land in the CRP.

The highly erodible cropland enrolled in the CRP must be planted to grasses, shrubs, or trees and cannot be used for any commercial purpose, including grazing, for at least 10 years. In return, owners or operators are paid half the cost of establishing the grass or tree cover. They also are paid an annual rental payment that compensates them for converting their cropland and reducing their acreage eligible for commodity program benefits.

The size of the rental fee is influenced by the competitive bids that potential participants make to USDA when they offer to enroll highly erodible cropland. Their bid is the rental fee they would accept in return for retiring that land. Reasonable bids are accepted, and a 10-year contract is established.

USDA accepted 64,967 bids from farmers during the three signup periods held in fiscal year 1986. These contracts convert more than 8.2 million acres of highly erodible land to grass, trees, or wildlife cover. Erosion will be reduced by an estimated average annual rate of 27 tons an acre or a total of nearly 209 million tons on this land alone.

Annual CRP rental payments for fiscal year 1986 contracts ranged up to $90 an acre and averaged $46 an acre. The CRP costs to the Government largely were offset by the reduced Commodity Credit Corporation direct outlays for deficiency payments and paid diversions and the reduced indirect outlays for storage loans that would have been made to program participants under the annual commodity programs.

The CRP retires precisely that cropland that is creating the problems associated with soil erosion.

Conservation Compliance. Farmers who opt not to enroll their highly erodible cropland in the CRP will be subject to conservation compliance as of 1990.

The Conservation Compliance provision requires those who continue producing crops on highly erodible land to develop and carry out an approved plan to prevent excessive erosion on that land or forfeit their rights to participate in farm programs. The 35 million acres of highly erodible cropland not eroding at excessive rates are already in compliance. For those farmers not in compliance, failure to carry out a conservation plan by 1995 will mean loss of eligibility for USDA price and income supports, disaster payments, crop insurance, Farmers Home Administration loans, storage loans and payments, and payments under CRP.

Sodbuster and Swampbuster. The "sodbuster" provision denies eligibility for these same program benefits to farmers who newly cultivate highly erodible land without using an approved conservation system. It is exactly the same as conservation compliance except that it applies to highly erodible land that has not been used for crop production since 1980. Approximately 225 million acres of highly erodible non-Federal land that has potential for conversion to cropland is subject to this provision.

Similarly, the wetland conservation provision, commonly known as "swampbuster," denies eligibility for USDA program benefits to individuals who convert wetlands for the production of agricultural commodities. About 5.1 million acres of the Nation's 76 million acres of wetland could potentially be converted to cropland.

Consistent Approach

Taken together, the major provisions of the conservation title provide a "carrot and stick" approach to retirement and careful management of highly erodible lands. None of these three provisions is mandatory. But failure to comply does carry a penalty. They penalize farmers who poorly manage vulnerable lands. And they create consistency between conservation and farm programs, and the three provisions complement each other.

When CRP contracts expire, the lands formerly in the conservation reserve become subject to the sodbuster provision. The beneficial effects on soil conservation should be long-lived.

The conservation provisions of the 1985 Food Security Act not only look new, they fit well and promise durability.

Conservation and Commodity Programs Can Work in Harmony

Gary A. Margheim, director,
Land Treatment Program Division,
Soil Conservation Service.

The Food Security Act of 1985 contains three conservation provisions that bring compatibility and consistency to USDA farm and conservation programs—Conservation Reserve, Wetland Conservation, and the Highly Erodible Land Conservation provisions. These provisions will lead to reduced soil erosion and associated offsite adverse effects, encourage conservation of natural wetlands, and promote a more productive and competitive agriculture.

The previous article, "A Farm Program With Incentives To Do Good," discusses each of these provisions. Here, let us take a longer look at conservation compliance under the Highly Erodible Land Conservation provisions.

Conservation Compliance

Conservation compliance applies to highly erodible land used to produce an agricultural commodity between December 31, 1980, and December 23, 1985. Some 118 million acres—more than one-fourth of the Nation's 421 million acres of existing cropland—are highly erodible and subject to conservation compliance. Producers of agricultural commodities on highly erodible cropland must develop by January 1, 1990, and carry out by January 1, 1995, an approved conservation plan to maintain eligibility for certain USDA program benefits.

Conservation plans include specific, practical conservation measures that will allow farmers to continue producing crops on highly erodible land while keeping soil erosion to acceptable levels. About 80 percent of all farmers producing on highly erodible land will want to maintain eligibility for USDA program benefits and will consequently need a conservation plan.

Effects of Conservation Compliance

Costs of Carrying Out Conservation Plans. The cost depends on the potential erodibility of the soil, the current level of erosion, and the degree of erosion reduction. Of the 118 million acres of highly erodible land subject to conservation compliance, about 83 million acres will need additional treatment to meet conservation compliance requirements.

A farmer has three choices on these areas: (1) Develop and apply an approved conservation plan and retain eligibility for USDA program benefits, (2) enter the land into CRP, or (3) continue to farm without an approved conservation plan and lose eligibility for certain USDA program benefits.

Of the 83 million acres requiring additional treatment, it is assumed that 45 million acres of the most difficult to treat will be enrolled in CRP. Bringing erosion down to acceptable levels on the remaining 38 million acres of highly erodible land under varying conditions requires different approaches with different installation and operating costs. In some cases conservation tillage, crop rotations, and contour plowing will be sufficient and compliance costs will be small. Some operators, however, may have to install terraces with greater up-front and maintenance costs.

An analysis of the 1983 Conservation Reporting Evaluation System data suggests that costs of bringing erosion on highly erodible land to a reasonable and practicable level would range from $25 to $60 an acre. Based on this data and judgment of professional conservationists, investments are expected to be between $800 million and $1.4 billion on the 38 million acres. Considering depreciated value of investment and reduced gross returns from crop rotations, the cost is about $7 to $13 an acre per year.

These costs are reasonably consistent with recent estimates of Dicks,[1] who estimated costs ranging from $7 to $17 an acre a year with a national average of $13.

Soil Erosion. The 118 million acres of cropland subject to conservation compliance are eroding at about 1.8 billion tons annually, or approximately 58 percent of the 3.1 billion tons of soil erosion occurring on all cropland. Conservation compliance will reduce erosion by up to 600 million tons annually, or about 20 percent of all cropland erosion. The actual level of erosion reduction will depend on the level of compliance that is technically and economically possible. With a 45-million-acre CRP and conservation compliance, 45 to 50 percent of all soil erosion on cropland would be eliminated. Soil erosion on cropland not meeting the highly erodible land definition would continue unless addressed by other traditional conservation efforts.

Soil Productivity. Reducing soil erosion will help maintain the long-term productivity of protected lands. Preliminary data from the Second Resources Conservation Act Appraisal of Soil, Water, and Related Resources indicate a national onsite annual loss in soil productivity of about 2.5 percent from sheet and rill erosion and about 1.2 percent from wind erosion. This translates to an average annual loss of about $125 to $150 million as a result of continued excessive soil erosion over the next 100 years. Conservation compliance along with CRP should reduce this loss by $70 to $90 million annually.

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[1] Michael R. Dicks, "What Will It Cost Farmers to Comply With Conservation Provisions?," *Agricultural Outlook*, Oct. 1986

Water Quality. The major adverse offsite effect of soil erosion is the degradation of water quality in the Nation's streams, reservoirs, and lakes. It is difficult to quantify damages to water caused by sediment from soil erosion and the extent to which erosion control measures would reduce them. Opportunities, however, for reducing these losses and damages are significant with conservation compliance and other provisions of the act. A recent study[2] indicates that about 400 million tons of sediment a year will not reach the waterways through these provisions. Based on Economic Research Service studies of offsite benefits per acre of land treated, the associated offsite benefits could approach $1 to $1.5 billion a year. These estimates do not account for benefits associated with land treated for wind erosion.

Social Considerations. Conservation compliance will create job opportunities in the private sector. Workers will be needed to install conservation practices, and the market for farm inputs used for conservation will expand. Employment for those engaged in land conversion activities is likely to be reduced. Depending on how it is ultimately implemented, conservation compliance could substantially affect the financial position and economic well-being of producers, suppliers, financial institutions, and rural communities.

These effects will vary, depending on inherent erodibility of the soil and specific crops grown. To minimize adverse effects, economics, social acceptance, and technical feasibility must be considered in determining the level of erosion control required by farmers to maintain their eligibility for USDA program benefits.

A social factor is the direct relationship between the quality of farmland and the socioeconomic status of operators. Farmers who have been prosperous are more likely to have better land, with less need for erosion control practices than limited resource farmers. Farmers on better quality land also are more likely to have higher education levels and better managerial skills, and to participate more actively in local and State conservation programs and organizations than farmers on poorer quality land.

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A Conservation Partnership Sets the Standards

Donald L. Basinger, director, and
David C. Ralston, national design engineer,
Engineering Division, Soil Conservation Service.

The U.S. Department of Agriculture (USDA) was the sole leader in research, planning, and application of soil and water conservation in the United States for many years. In the 1980's, however, the Federal Government's role changed from that of source to partner with private organizations as well as State and local governments.

Some of the forces behind the shift are:

- Reduced Federal Budgets;
- Public concern over the environmental effects of land abuse;
- Public concern over the offsite effects of runoff;
- Local concern about causes and responsibilities for nonpoint source pollution;
- Increased awareness that ground water and surface water must be considered jointly;
- Established standards and specifications that provide for pollution control;
- Stronger role of State and local governments in conservation work on non-Federal land; and
- Adoption of established standards for pollution control by local units of government and professional organizations.

SCS Standards Facilitate Change

The Soil Conservation Service (SCS), the lead agency of USDA in soil and water conservation, began assisting landowners in constructing field conservation measures in the 1930's and 1940's. The landowners arranged and carried out the construction, which SCS designed.

Starting in the mid-1950's through 1980 local contractors and equipment manufacturers worked cooperatively with Federal and State conservation agencies and soil and water conservation districts to do conservation work more quickly. Training sessions and demonstrations in design and construction layout were held. Where this occurred, SCS technical assistance to landowners was limited, but qualified contractors were available. The work on highly productive agricultural land usually involved terracing, land level-

As farming methods change, engineering design standards are modified to accommodate the new techniques and equipment. A grassed, steep back-sloped terrace and tile outlet help conserve soil on an Iowa cornfield. (SCS)

ing, irrigation canal lining, and tile drainage. SCS standards and specifications, originally developed for employees in the field, were used for this work.

These standards helped to assure landowners of quality necessary for a credible job of conservation. Other Federal and State agencies, consulting firms, and towns and counties have used them as a starting point for developing consensus industry standards in soil and water conservation.

Consensus Industry Standards

To increase efficiency, the Federal Government in 1968 grew interested in the development and use of consensus industry standards. Circular A-119, "Federal Participation in the Development and Use of Voluntary Standards," issued by the Office of Management and Budget, became effective March 1, 1983. It calls for each Federal contracting officer to give preference to voluntary standards when describing a product or a service. SCS helped lead the way in the use of industry consensus standards when a shift was made in 1964 to use American Society of Testing Materials (ASTM) and other authorities in place of specifications developed by Federal agencies.

USDA Contributes to Industry Standards

Working with ASTM. USDA engineers participate with engineers throughout government, industry, and academia in ASTM. Its standards, developed jointly by users and producers of products, procedures, and quality control tests, are the accepted procedures and quality control standards for the industry. Manufacturers use them both in production and in testing. These standards also are useful in the competitive pricing of quality products. This society currently has 30,000 active members, operates through 140 main technical committees, and is the world's largest source of voluntary consensus standards.

Benefits from Industry Standards. USDA benefits by having the products, procedures, and quality control tests that are used in soil and water conservation included in ASTM standards. They eventually become industry standards. Not only does this minimize time and effort in preparing specifications, but also installation costs are substantially reduced.

SCS recently issued the *Surge Irrigation Field Guide* which they developed in cooperation with the Agricultural Research Service, universities, and industry for technicians and land users. This new technology guide provides for standardization of equipment, recommendations for use, and help for the farmer in decisionmaking. An industry standard that evolves from a consensus process will be the next step.

Working With ASAE. Many USDA engineers are members of the American Society of Agricultural Engineers (ASAE) and participate on committees to develop consensus standards and specifications. ASAE is the principal engineering standards-writing organization for agriculture equipment, systems, and processes, supporting a global system of international standards. ASAE standards exemplify the cooperation of interest groups working together to develop standards acceptable to all.

Other USDA Participation. Some of the professional and industrial organizations with which USDA employees have worked in the developing of standards have been the National Association of Conservation Districts (NACD), Land Improvement Contractors of America (LICA), Associated General Contractors (AGC), Farm and Industrial Equipment Institute (FIEI), and the American Society of Civil Engineers (ASCE).

Many of the USDA agencies have made contributions to the development of agency and industry consensus standards. The most active have been employees of the Forest Service, Extension Service, and SCS.

Soil and Water Conservation Standards

SCS is working with technical and professional societies to establish technical standards for systems of soil and water conservation measures. These groups are involved with hydrology, hydraulics. geology, soil mechanics, landscape architecture, stream mechanics, structures, and corrosion. The concept of developing industry standards by consensus is being expanded to include soil and water conservation in view of the increasing regulation of natural resources conservation by State and local governments.

Based on proven standards, a parking lot storm runoff management system of multiple outlets safely carries away intense rainfall—controlling flooding and erosion. (Gene Alexander, SCS, OH-60,975)

Expanding Technology

Significant technological progress has been made in the basic and applied soil and water sciences. This has led to greater public understanding of resource degradation as well as support for resource conservation. The improved technology is the product of public and private institutions, organizations, and individuals.

The effort was spurred by the environmental concerns of the 1960's and 1970's. Studies were initiated to assess requirements of the National Environmental Policy Act of 1969. They ranged from examining whole watersheds and river basins to determining how a soil particle was moved from a point of origin and what chemicals or organic compounds went along for the ride.

These studies produced reports, standards, criteria, rules, and regulations. The work was done largely through contracts with private firms, through contracts and agreements with colleges and universities, and by employees in Federal and State agencies.

The data that was produced has been used by engineers, architects, and other technicians as well as by companies, contractors, and government agencies, knowledgeable in conservation and development of soil and water resources.

A stone-center sodded waterway that safely handles storm runoff is based on proven standards that allow for flexibility, esthetics, and low-cost maintenance. (J.F. Hazen, SCS, MD-30,501)

Future Partnership

A reduced Federal work force and increased responsibilities in carrying out the 1985 Food Security Act have made it necessary for USDA to involve more people in soil and water conservation projects. Conservation contractors, land users, and volunteers are being trained to layout, install, and check the simpler practices. Special interagency and Federal-State agencies are developing training modules for use by local groups and individuals. This concept also is being applied to dam safety so that landowners and sponsors fully understand their responsibilities for operations, maintenance, and safety inspections.

A Federal-State-local partnership must be established and maintained to manage the Nation's soil and water resources. This network is essential for technology transfer and feedback through personal contacts and participation. The 1985 Food Security Act and the Clean Water Act of 1987 present opportunities for Federal-State-local cooperation on soil and water conservation projects, including some dealing with nonpoint source pollution control. SCS can assist in developing standards and specifications that will be acceptable to all groups.

Technology, Land, and Fate

Paul Fuglestad, agricultural economist,
Appraisal and Program Development Division,
Soil Conservation Service

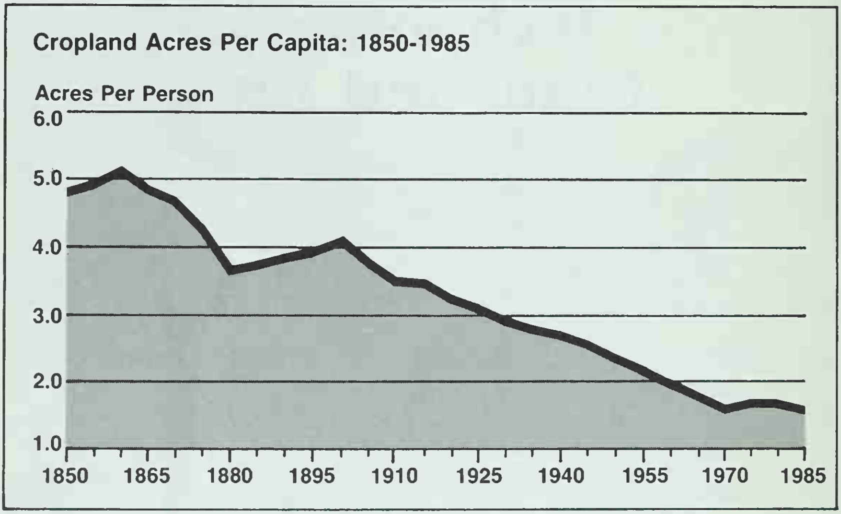
Agricultural research and recent advances—particularly in biotechnology—promise to revolutionize agricultural production. A continuation of the century-old Agricultural Revolution, today's advances have profound implications for America's relationship with its land. The society of Jefferson's yeoman farmers has been supplanted by a landless society of technical innovators who entrust the land and its productivity to a mere 1 percent of its members.

Concern for the land fluctuates over time. Two hundred years ago Malthus wrote that scarcity and eventual famine was inevitable given our predilection for procreation, a thesis that forever earned economics the appellation ''dismal science.'' In 1898, a world ''wheat crisis'' evoked a new round of worry over scarcities. In the present century, concerns of scarcity crop up periodically, the last in the mid-1970's. Now, in 10 year's time, declining demand has pushed prices to new lows and economic stress in the farm sector to new highs. What is the norm? Will food supplies be in shortage or in surfeit? Will land undergo intense pressure for food production or lie unattended? The advent of new food production technology, as in the past, will have great impact on the use of—and the need for—land.

Knowledge, Productivity, and Land

Midway between Malthus and the 20th Century the Industrial Revolution began to displace the frontiers of resource scarcity. One of its offshoots is, of course, the Agricultural Revolution which has a direct bearing on the use of land for food and fiber production. Professor Vernon Ruttan, in a 1982 book, has written that the significance of technical change is that it permits the substitution of knowledge for resources and increases productivity.

The term ''productivity'' refers to the amount of output (product) generated per unit of input or per unit of an amalgam of several inputs. It is measured as a ratio. For productivity growth to occur, new knowledge (technology) must be combined with appropriate input factors to enlarge the productivity ratio, that is, increase the amount of output per unit of input.



Labor Productivity. Historically, innovation has increased agricultural productivity ratios over time whether they be ratios of output to labor, output to capital, or output to land. A century ago labor was beginning to become scarce, partly because of the Civil War and partly because of increased labor costs fostered by off-farm competition from the factories of the Industrial Revolution. In response, for example, the binder introduced in the late 19th century harvested wheat with 60 percent fewer workers than with the McCormick reaper. This innovation significantly increased the ratio of output to agricultural labor.

Land Productivity. Ratios of outputs to land—land productivity ratios—also have increased. The close of the frontier made it more difficult to increase production simply by expanding to new acreages. In fact, total cropland acreage has been roughly constant since about 1910. In 1910 land used for crops totaled 324 million acres; in 1985 it was 372 million acres, with 87 million acres producing commodities for export. However, output has increased tremendously. Between 1910 and 1985 the U.S. population had increased from 92 million to 239 million while corn and wheat production increased three times.

Land productivity ratios can be depicted in several ways, the most usual being a composite index of crop production per acre. Another indicator of land productivity is acres per capita. For the last 135 years—and especially since 1900—acres of cropland per person have been steadily declining. The trend was halted in 1970 because of the greater role of exports in the agricultural demand picture. If exports and government programs were accounted for, the downtrend would be even more precipitous.

Early agricultural innovation served

to substitute knowledge and capital for labor. Later in the Agricultural Revolution, knowledge and capital began to substitute for land, increasing output per unit of land input. Plant breeding, fertilizer, chemicals, and irrigation combined with improved management techniques to increase yields. Improvement in livestock productivity reduced the land needed for producing livestock feed.

Technology and Conservation

While some analysts argue that yields appear to be leveling off and that the Agricultural Revolution is over, others point to research and development— both public and private— in biotechnology and information management.

Within the decade, animal agriculture will become more efficient because of biotechnical breakthroughs. The bovine growth hormone developed at Cornell University is a dramatic example. Improvements in plant productivity resulting from advances in biotechnology will occur sometime after 2000.

The information revolution also will influence agriculture. Computerized information data bases and decision models will greatly improve agricultural decisionmaking and management efficiency. These changes should be firmly entrenched in another decade.

What do these new technologies mean for land use and conservation? Projections of land productivity improvements to 2000 and 2030 range from 1.2 to 1.7 percent annually for corn, soybeans, and wheat. The Census Bureau projects a decline in U.S. population growth rates from 1 percent annually in 1985 to 0.1 percent annually by 2040. The need for cropland acreage will decline unless export demands increase steadily over time. With the long-term trends indicating that technology will increasingly substitute for cropland, is there really a need to preserve the cropland base and to conserve the soil and water resources it represents?

In the short term there will be aberrations that will depart from the long-term trend. Weather is an important and uncontrollable factor in agricultural production. A sharp increase in the cost of fossil fuels relative to other inputs, too, can have an impact on cropland use, particularly if the cost differences foster the development of an extensive, land-using type of agricultural technology.

It is not certain, either, if trends in the long term will follow historic patterns. Global climate change is well within the realm of possibility. The "greenhouse effect," if viable, can have drastic impacts on agricultural production, effectively moving the temperate cropping zone several hundred miles to the north or south.

The United States has the luxury and responsibility of adequate cropland. If this resource is compromised, the risk exists that it will become inadequate. The need to conserve and improve agricultural land is as great as ever.

Planning the Future of the Nation's Forests

J. Lamar Beasley, deputy chief,
National Forest System,
Forest Service

Managing 156 National Forests covering 191 million acres demands sophisticated planning to coordinate their many uses. The National Forest provides quality water, timber, minerals, wildlife and fish, forage, open space, scenic beauty, and outdoor recreation, but the land and its resources must be carefully managed to assure their availability for future generations.

Evolution of Forest Service Planning.

Planning is not new to the Forest Service; it has long recognized the necessity of good planning. In the early 1900's separate plans were developed for individual natural resources, but the main focus was on timber and range. The next 70 years brought about sweeping changes in the way the National Forests were to be planned for and managed. It was culminated by Congress' passage of the National Forest Management Act of 1976.

In the intervening years, watershed protection came to prominence as the Weeks Act passed in 1911. The need

The National Forests annually produce more than 11 billion board feet of timber for housing and other wood products, 13 million barrels of oil, 180 trillion cubic feet of natural gas, 21 million tons of coal, 10 million animal unit months of grazing for cattle, 425 million acre-feet of water for human consumption and irrigation, 225 million recreation visitor days, and many other economically valuable products and services. They also contain more than 32 million acres of congressionally designated wilderness and about half the Nation's big-game animals.

Planning for wise use of land and resources is not only an investment in the future, it pays dividends today! Certainly a primary responsibility of land managers is to decide how to best manage public lands to assure adequate levels of materials and services for future generations. Because natural resources are limited, they are tremendously valuable. The planning process is designed to produce significant and far-reaching decisions on how these resources can be shared fairly by all Americans.

for recreation and wilderness was recognized during the 1920's and 1930's as more people began visiting the forests. Natural resource uses began to compete with each other as demands increased. By the 1950's it was evident that a new approach was needed.

Multiple Use-Sustained Yield Act

This 1960 act, the Forest Service's first comprehensive effort to accommodate conflicting uses of the National Forest System, established the concept of multiple use management as a national policy.

It said that National Forests are established for, and must be administered for, the purposes of outdoor recreation, range, timber, watershed, and fish and wildlife. *Multiple Use* is defined, in part, as the management of all the various renewable surface resources of the National Forests so that they are used in the combination that will best meet the needs of the people. *Sustained Yield* is defined as the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the National Forest without impairment of the productivity of the land.

National Forest Management Act of 1976

Congress, recognizing the necessity of integrated planning and balanced use among all resources, passed the National Forest Management Act (NFMA) in the following decade. Its passage marked the beginning of a new era for Federal forestry. It equipped the Forest Service with the tools needed to practice scientific forest management in a way that would benefit the most people. Separate resource functional and unit plans, which had resulted in loosely coordinated management, were to be replaced with one integrated land and resource management plan for each National Forest encompassing all activities. NFMA legislation offered great potential for sound management of the National Forests in the public interest.

This legislation was originally proposed in response to a Federal court's decision that timber harvesting practices on three timber sales in the Monongahela National Forest were illegal. It was prompted by a lawsuit, growing out of a campaign by conservationists against what they contended was overemphasis on timber harvesting in National Forests. Although limited to sales on the Monongahela, this decision was extended by the Forest Service to the nine National Forests under jurisdiction of the Fourth Circuit Court of Appeals. Estimated nationwide application of the decision would have resulted in a 50-percent reduction in National Forest timber harvests. The court recognized the impact of its decision and suggested legislative remedy for the outdated portion of the 1897 Organic Act, which allowed that only "dead, physiologically mature, and large growth trees" individually marked for cutting, could be sold.

With the help of a committee of non-Forest Service scientists, comprehensive regulations were drafted and redrafted to implement the 1976 statute. The Secretary of Agriculture in 1982 approved final regulations requiring basic changes in the Forest Service's traditional resource management planning. NFMA constituted a commitment to land management planning as the primary means to effectively manage the renewable resources of the National Forests in an environmentally sound way. It represented balanced considerations of all resources through the land management planning process. Integrated, long-range land management plans (Forest Plans) must now be developed for each National Forest unit (123 National Forest Plans encompassing all 156 forests).

Land Management Planning Process

Although it is impossible to resolve all issues concerned with distributing the resources found on National Forest lands, the accepted premise was that a proper balance of the uses can be achieved through development of comprehensive long-range plans. Land management planning was to be a continuing process responding to changes in the demands made on the supply of renewable resources.

No one at first understood the size and complexity of the planning job. Many possible alternatives exist for future management of a single National Forest. Because of the long-term nature of forests, it is necessary to look ahead for 50 years (even though Forest Plans will set management direction for only 10–15 years.

Land management planning determines the best use of the resources found within the National Forests. The public is involved in developing an integrated plan of management for each administrative National Forest.

In response to the requirements of the NFMA, a Land and Resource Management Plan, commonly referred to as a Forest Plan, is used by the managers for making land-use decisions. It details how resources are to be managed to attain specific management objectives. Forest Plans also address the environmental effects of meeting management objectives and provide information on the budget requirements for carrying out the work.

Forest Plans are not created in a vacuum. Nine regional guides provide national and regional direction in developing them. Included in the guides are major issues and management concerns of the regions as well as resource objectives recommended for each National Forest. The guide insures that a consistent approach to National Forest planning is followed throughout the region, but it allows for considerable latitude in formulating individual plans.

Public involvement is important in the planning process. The public, often with conflicting interests, is encouraged to identify current issues and future needs, and to recommend the management activities to be implemented and the goods and services to be produced. The public also is invited

A Forest Service employee evaluates tree spacing after a private contractor has thinned a section of the Idaho Panhandle National Forest. Thinning improves the remaining timber by letting in more light for better growth. (D. Jaquish, FS, TN16)

to review the draft Forest Plan and the accompanying environmental impact statement and respond in writing. This is a key factor in increasing public awareness and support for management of the National Forests. Public participation in planning begins early in the process and is continuous throughout.

The following 10 actions take place in preparing these plans:

1. Identifying public issues, management concerns, and resource use and development opportunities to enable planning to be concentrated in areas of specific interests.
2. Formulating planning criteria to guide the planning process. These criteria may apply to data collection, analysis, or evaluation of alternatives.
3. Identifying and collecting data and information required.
4. Analyzing the capability of the planning area to supply goods and services in response to society's demands.
5. Developing management alternatives that are consistent with the capability of the area and resolve the pertinent issues and concerns.
6. Determining the effects of all these alternatives on the environment, including potential economic, social, biological, and physical effects.
7. Comparing alternatives in terms of management activities, resource

outputs, public benefits, and response to national and regional goals.

8. Identifying a preferred management alternative based on alternative comparison and—subsequent to public comment—approving the management plan.

9. Implementing the approved plan, consistent with the annual budget and work plan.

10. Monitoring and evaluating selected ongoing management activities as an integral part of carrying out the plan. This is done to ensure that the planning criteria and assumptions used to develop the plan were correct and that the plan is carried out in accordance with management standards and guidelines.

Planning Demands New Technology

Because of the mass of data and the many combinations used to describe alternatives, new technology was needed. The answer was a computer modeling system to aid forest managers in assessing the cause and effect relationships of different management activities. The necessary quantitative integration of multiple uses could be obtained through the use of a linear programming model. In general, a linear programming model allocates scarce or limited resources among competing activities to identify the best mix possible. This planning system developed by the Forest Service is called "FORPLAN."

Another planning tool developed by the Forest Service is an input/output model called "IMPLAN." The IMPLAN computer system describes the economic relationships among businesses within each of the Nation's 3,134 counties. It estimates employment, wages, and business income changes as a result of managing the National Forests in any of the ways identified by a plan. Currently, the system is being used by other Federal agencies, a variety of State agencies, and several universities for national, State, and local studies.

Keeping Plans Current

The Forest Service, in cooperation with the public, will continue to update and amend plans even after they are developed to allow for changing conditions and to ensure that adequate resources will be available to meet the future needs of the American people.

Tax Policy and Agricultural Land

Ron Durst, leader, Tax Analysis Section, and Ronald A. Jeremias,
economist, Economic Research Service

The Tax Reform Act of 1986, the most comprehensive overhaul of our Federal income tax system in more than 30 years, has substantially lowered tax rates while eliminating or reducing many deductions, exclusions, and credits introduced over the years. This tax law, like those before it, affects farmland values and ownership and land use and conservation.

Land Value and Ownership Before 1986

During the 1960's and 1970's, the Federal income tax had some substantial effects on land ownership and land value resulting from different tax treatment of various types of investments and investors. Land received more favorable tax treatment than other investments. The tax incentives for land investments were greater for those in higher tax brackets, those who borrowed to buy land, and those who held their land for long periods before resale. The result was higher land values, more concentration of land ownership, more debt loads and risk for landowners, and a less active land market.

Capital Gains Exclusions. Since 1954, a portion of all long-term capital gains has been excluded from taxation. From 1978 to 1986, the exclusion was 60 percent, with only 40 percent of any gain taxable. During the 1970's, when rising farm incomes were raising the real value of land, the exclusion (and postponement of tax until sale) increased the attractiveness of land investments. Many considered farmland as a tax shelter.

Interest Rates Deduction. During the 1970's, nominal interest rates were high as a result of inflation, but the real cost of borrowing was relatively low, primarily as a result of the tax savings from interest deductibility. In some cases, real after-tax interest rates were negative. As a result, larger profits were made by those who borrowed a larger portion of the cost of any investment. Land became an attractive investment because it was good security, and lenders were willing to finance a high portion of the investment cost.

Tax Savings in 1970's. The capital gains exclusion and the deductibility of nominal interest provided tax savings greater for those in higher tax brackets. During the 1970's, individuals with high incomes were encouraged to invest more of their wealth in land, and less in other assets, serving to increase the rate of growth in real land values. Those with low incomes received smaller tax benefits from land ownership. They often could not afford to buy or hold land at the higher prices, which contributed to the decline in the number of farms and the increase in average farm size, and led to a greater concentration of land ownership.

Reduced Tax Benefits in 1980's. During the 1980's, the effects of tax policy on farmland were overshadowed by declines in farm income and increased farm financial stress. In 1980, when farmland values began falling, the capital gains exclusion lost much of its value as a tax incentive for land ownership. At about the same time, interest rates and inflation began to fall, further reducing the tax benefits of the deductibility of nominal interest. Farmland was no longer viewed as a tax shelter.

Land Value and Ownership Under Tax Reform

The most significant change in the 1986 tax law is the sharp decline in tax rates from a top tax rate on personal income of 50 percent to 28 percent by 1988. This reduces the overall effects of tax policy on investment decisions, and raises the after-tax return on most investments, including land. As an example, consider farmland that rents for $100 an acre. Under old law, a high-income landowner would pay half the rent in income taxes, keeping only $50 an acre. By 1988, the same landowner will earn $72 an acre after taxes, an increase of 44 percent.

The benefits of lower tax rates are partly offset by the elimination of a number of special tax provisions. For land, the 60-percent exclusion for long-term capital gains is eliminated. This loss will gain importance when the land market stabilizes and nominal land values begin to keep pace with inflation. Under old law, with a top tax rate of 50 percent, the maximum tax on capital gains was 20 percent. Under the new law, capital gains are being taxed at the same rate as ordinary income. Those in the top tax bracket will pay a tax of 28 percent on any nominal gains in land value. Landowners, however, will continue to benefit from the postponement of the tax until the time of sale. For those who hold their land for long periods, the higher capital gains tax will be more than offset by the lower tax on current land income. The net result should be higher after-tax returns on land investments.

Land Use and Conservation Before 1986

For the past 30 years or more, the Federal income tax code has contained a number of provisions for special tax treatment of expenditures on soil and water conservation and land improvements. Farmers' decisions with regard to soil and water conservation and management have sometimes been based more on these tax benefits than on economic returns. In addition, some tax incentives for land improvements have encouraged more intensive cropping that may have led to increased soil erosion. Consequently, the tax law has had mixed effects on farm resource management.

Tax Deductions for Soil and Water Conservation. Farmers have been allowed to claim immediate tax deductions for certain types of expenditures on soil and water conservation since 1954. These expenses have included the leveling, grading, and terracing of land; custom furrowing; the planting of windbreaks; and the construction, control, and protection of diversion channels, drainage ditches, earthen dams, watercourses, outlets, and ponds. This list includes all conservation expenditures that taxpayers would normally add to the basis of land and deduct for tax purposes in the year the land was sold. Each farmer's annual conservation deductions have been limited to 25 percent of gross farm income.

The conservation practices listed are used on about one-fourth of the U.S. cropland treated with some method of erosion control. Conservation tillage is now used on about half of all treated land and is by far the most widely used method of erosion control. It normally requires special tillage equipment.

Land Clearing and Land Improvements. Farmers also have been allowed to claim immediate tax deductions for most expenditures on land clearing and land improvements since 1954. Examples of land clearing include diversion of streams and eradication of trees, stumps, and brush. Each farmer's annual deductions for land clearing have been limited to the lesser of $5,000 or 25 percent of taxable farm income. Examples of land improvements include earth moving, draining, the filling of wetlands, and preparing land for center-pivot irrigation. Total land improvement and conservation deductions have been limited to 25 percent of gross farm income.

Several types of land improvements such as drainage tile and concrete dams must be depreciated. However, they have been eligible for the investment tax credit and rapid write-off periods. For some taxpayers, the tax credit and rapid write-offs have provided greater tax savings than immediate deductibility.

The immediate deductibility of land-clearing expenses has encouraged the conversion of wetlands and other land into cropland. Some of this conversion would not have been profitable in the absence of the tax savings from the immediate deductions, because the land was not well suited for crop production. In addition, a tax subsidy for land conversions may have contributed to overproduction in agriculture and lower farm product prices. Immediate tax deductions for land improvements also have been questioned. Some land improvements such as drainage and preparation for irrigation may have led to more intensive cropping that has increased soil erosion.

Investment Tax Credit. Since 1962 (with brief interruptions), nearly all investments in farm and nonfarm equipment have been eligible for the

Plastic drainage tubing is installed on a North Carolina farm. New tax laws have eliminated investment tax credits and extended to 15 years the write-off period for installation of land improvements such as drainage systems. (John B. Litchfield, SCS, NC-2,199)

investment tax credit and accelerated tax depreciation schedules. In addition, since 1982, each business taxpayer has been allowed to immediately deduct up to $5,000 of investment in machinery equipment. At least three-fourths of all conservation practices have benefited from some type of special tax provision.

Land Use and Conservation Under Tax Reform.

Some of the special tax benefits in prior law have been restricted or eliminated, including those provisions that had encouraged the conversion of marginal lands into cropland. The new law is more neutral in its treatment of the various conservation methods and should have a positive effect on resource management.

Conservation Measures Still Deductible. Farmers may claim immediate tax deductions for soil and water conservation only when the expenses are consistent with a conservation plan approved by the U.S. Department of Agriculture (USDA) or a comparable State agency. The plan need not be specific to the individual farm. USDA and some State agencies have developed areawide plans that indicate the types of conservation measures considered suitable. Most conservation measures will remain deductible under the new law.

Depreciable Investment Incentives Reduced. Under old law, tillage equipment, drainage tile, concrete dams, and many other farm assets were eligible for a 10-percent investment tax credit and 5-year write-off periods. The new law repeals the investment tax credit retroactive to January 1, 1986. It also lengthens write-off periods to 15 years for drainage tile, concrete dams, and similar land improvements, and to 7 years for tillage equipment and most other farm assets. However, the option to expense up to $5,000 of investment a year has been raised to $10,000.

Land Clearing and Improvement Incentives Reduced. The Tax Reform Act repealed the immediate deductibility of expenditures on land clearing and land improvements. They must now be added to the basis of land, so they are not deductible until the land is sold. This change will reduce the incentive to bring marginal land into production, and it will remove the tax incentive for the land improvements that have led to increased soil erosion. Routine brush clearing and similar activities on land already in production will continue to be currently deductible as ordinary business expenses.

Conversion of Wetlands Discouraged. The Tax Reform Act also discourages the conversion of wetland or highly erodible land to cropland. Under the new law, any gain on the sale of such land is taxed as ordinary income and any loss is treated as a long-term capital loss. Since capital gains and ordinary income are taxed at the same rate under the new law, the most significant effect of this change is that losses on the sale of such land may only be used to offset up to $3,000 of ordinary income each year. The remaining loss must be carried forward to future tax years. If ordinary income tax rates are increased or if the capital gains exclusion is restored in the future, the tax penalty for converting land would increase.

Incentives for Developing Orchards and Vineyards Reduced. Under old law, farmers could claim immediate tax deductions for such development costs. Now these costs must be capitalized, which reduces the profitability of orchard and vineyard investments and may lead to a decline in orchard and vineyard acreage.

Incentives for Forestry Retained. The major change is the loss of the capital gains exclusion, which is mitigated by the fact that the tax is not paid until trees are cut or sold. Under the new law, taxpayers may continue to claim immediate tax deductions for the costs of maintaining forests. The new law also retains the 10-percent investment tax credit and the short 7-year amortization period for reforestation expenditures.

The South's Fourth Forest

Dwight Hair, senior scientist,
Forest Service

About two-fifths of all U.S. timberland is in the South—a region that includes Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Arkansas, Louisiana, Texas, Oklahoma and Tennessee. Timberland accounts for 2 or 3 of every 5 acres in all these States except Texas and Oklahoma. More acres are in timberland than in cropland and pasture combined.

Economic Importance

The total value of the timber harvested in 1984—sawlogs, veneer logs, pulpwood, and other round products—is about twice that of the soybeans or cotton harvested in the South and three times the value of the tobacco, wheat, or corn crops.

The Southern States produced two-thirds of the Nation's woodpulp, close to half of all hardwood and softwood plywood, two-fifths of the hardwood lumber, and one-third of the softwood lumber.

The South's forest processing industries employ one out of every nine workers in the manufacturing industries and pay $1 out of every $10 in wages and salaries. Employment and wages and salaries exceed those in other industries such as textiles, apparel, processed food, chemicals, electric and electronic equipment, nonelectrical machinery, and transportation equipment.

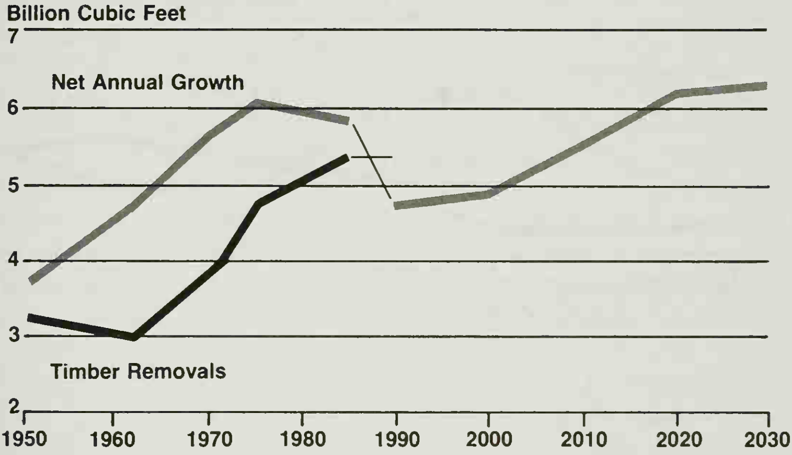
How It Came About

Timber harvesting was not a major factor affecting Southern forests until after the Civil War. Timber harvesting accelerated as railroads extended into the vast pine forests on the Coastal Plain, the technology for sawing large volumes of timber was put into practice, and huge markets for lumber developed in the North. From about the 1880's until the 1920's, large areas of timberland were harvested. Some of this land was used for crops and much bigger areas for grazing. Because of such use and uncontrolled fires which burned over large areas each year, only a part of the cutover lands came back to forests.

The Second Forest. Some lands, however, did return to forest. The early 1900's marked the beginning of the South's second forest, supplying the wood for the expansion of the pulp and paper industry in the 1930's and into the 1960's.

By the early 1920's, the use of

Softwood Net Annual Growth and Timber Removals in the South, All Ownerships



land for crops and grazing peaked and began to decline. Concern among forest industry and government leaders about timber supplies and the lack of regeneration of large areas of cutover lands led to (1) developing programs of fire protection, technical and financial assistance, research, and education, and (2) establishing managed public, industry, and other private forests. Fire protection and fire prevention programs were especially effective, and a large part of the cutover and idle crop and grazing land regenerated naturally. Research led to ways to protect and regenerate forests and use southern pine timber for products such as pulp and plywood.

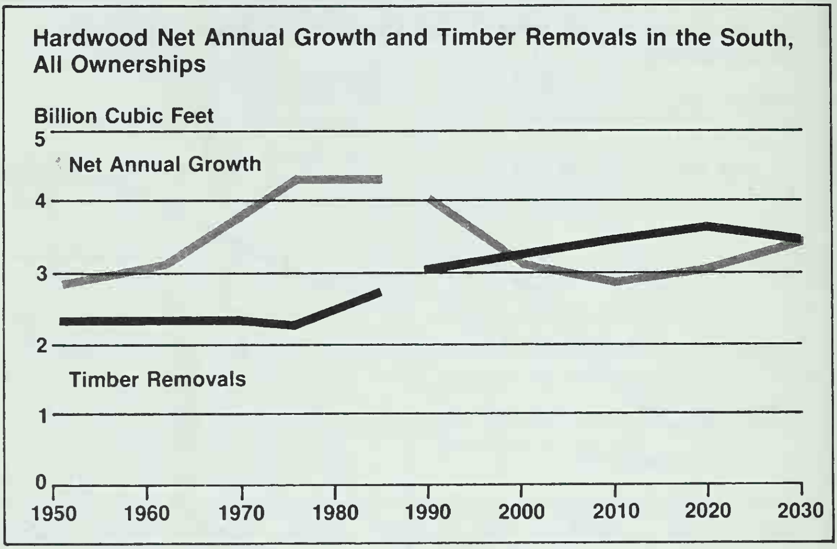
The Third Forest. These same forces continued to affect the timber situation for several decades, leading to a great achievement in the history of forestry, the regeneration and the growth of the South's third forest. This forest is the source of the wood used by the forest industries that are now such an important part of the South's economy.

Timber Growth Declining

Net annual timber growth for softwoods and hardwoods, after rising for decades, has leveled off or begun to decline.

The four major causes of the changes in softwood growth are:

1. The lack of adequate regeneration of pine stands after harvest on privately owned lands other than those in the forest industry. The natural succession in most of the pine stands in the second and third forests after harvest is to mixed hardwoods and pine or to hardwoods. Many of the other private owners in the South accept whatever species nature pro-



vides. As a result, the latest forest surveys show a 30- to 50-percent decline in the number of pine saplings on these lands.

2. The doubling of annual pine mortality in the South over the last 10 years. Much of this increase comes from outbreaks of pine bark beetles.

3. A drop in radial growth in the Piedmont and Mountain regions of Georgia, South Carolina, North Carolina, and Virginia. In these areas, average annual radial pine growth has been 20 to 30 percent lower during the last 10 years than in the preceding 10.

4. The conversion of timberland to cropland and pasture or urban and other nontimber uses. Since the early 1960's the South's timberland has declined from 197 million to 182 million acres. Hardwood growth also has been affected.

During the leveling off or decline of net annual timber growth, timber harvests have increased to meet rapidly expanding national demands for timber products. As a result, softwood timber removals are above net annual growth over large areas in the South. Net annual hardwood growth is still above removals, but the trends are converging.

Cost Increases Likely

Projections show that the trends in net annual growth and removals will persist. Net annual growth of softwoods declines until the 1990's, and that for hardwoods until 2010 after which net annual growth rises again. Timber removals continue to rise although at a much slower rate than during the last couple of decades. As a result of these trends, softwood timber inventories decrease from the 1990's until after 2000, then rise through the rest of the projection period. Hardwood inventories rise until 2000, then decline.

Rising Prices Increases in the real prices of stumpage, that is, prices net of inflation or deflation, in the South are largest in the early part of the projection period when net annual softwood timber growth and inventories are declining. Between 1984 and 2000, for example, softwood sawtimber prices are projected to rise at an annual rate of 3.1 percent in the South Central States. Consumers will pay more for all the wood products they buy.

Hardwood stumpage prices do not change much until around 2000. After 2000, as timber removals rise above net annual growth and inventories begin to decrease, prices begin to rise. From 2010 to 2030 hardwood sawtimber prices go up at a rate of 1.7 percent a year in the South Central States.

In highly competitive markets, rising prices act to constrain demands. As a result, softwood timber supplies rise slowly over the projection period, much below the increases since the early 1960's. Hardwood harvests rise in the first three decades; then they level off and begin to decline.

Fewer Workers Needed. The increases in harvests are too small to sustain employment in the forest industries. By 1990 employment is projected to drop. By 2030 total employment in the lumber and wood products and pulp and paper industries will be 25 percent, some 108,000 people below the 1983 employment level. Total wages and salaries also decline. The effects are multiplied as they spread through the trade, service, transportation, and other parts of the southern economy providing goods and services to the forestry sector.

Decreasing Exports—Increasing Substitutes. Exports of most timber products will decrease, and use of substitute products such as concrete, steel, aluminum, and plastic will increase. More and more nonrenewable resources, including the ore and fossil fuels used in the production of these substitutes, will be removed from the country's finite supply. In addition, the mining, industrial processing, and power generation required to make timber substitutes will result in more air and water pollution.

Cost Increases Likely—But Not Inevitable

The kinds of cost increases projected are not inevitable, however. The development of the South's fourth forest can be managed, and the forest can take almost any form desired.

Economic opportunities yielding 4 percent or more net of inflation or deflation exist to increase timber supplies on 70 million acres of timberland in the South. They would increase net annual timber growth by 3.2 billion cubic feet, a volume equal to 55 percent of the current net annual softwood growth.

In addition, about 8 million acres of cropland and pasture would yield higher rates of return to the owners if they were planted to pine. Also 11

Trees are planted by machine in Mississippi's Desoto National Forest. Many opportunities exist to increase timber supplies in the South through tree planting and other management practices. (FS)

million acres of highly erodible cropland is suitable for growing trees. All of these lands are marginal for crop and pasture use. If planted to pine, they would produce about 1.8 billion cubic feet of net annual timber growth a year—0.8 billion on the marginal cropland and pasture and over 1 billion on the highly erodible cropland.

In total, net annual timber growth could be increased by 5 billion cubic feet nearly doubling current net annual softwood growth. This development would support continued growth in the South's forest industries and, in turn, in employment and wages and salaries.

You Make a Difference

Wilson Scaling, chief,
Soil Conservation Service

If you set out to improve this land of ours and you're successful, you're going to enjoy it. And so will the folks who come after you.

With some 2.3 billion acres, the United States is rich in its variety of soil and water resources. Sixty-one percent of the land is privately owned while 39 percent is owned by Federal, State, and local governments. Despite the fact that most of our population lives in urban areas, most of our land is agricultural—used primarily as cropland, rangeland, forest land, and pasture. That is one reason farmers and ranchers play such a key role in the conservation of our Nation's soil and water resources.

The care of the earth is a challenge...whether used for a farm or ranch, a national forest, a shopping center, a schoolground, or a homesite. Landowners have many decisions to make to take proper care of their land. That is true whether they're the farmer or rancher developing and carrying out a soil and water conservation plan or the homeowner with a backyard soil erosion problem.

Americans have private property rights. But with rights comes responsibility—to take care of the land and water that make America great. The land provides us with basic needs like food and water and shelter, and so much more. It will continue to do so, if we take care of it.

What can one person do? A lot. Together, we can accomplish even more. As farmers and ranchers...as professional conservationists...as community leaders...as teachers and students...as volunteers.

Conservation on the Farm

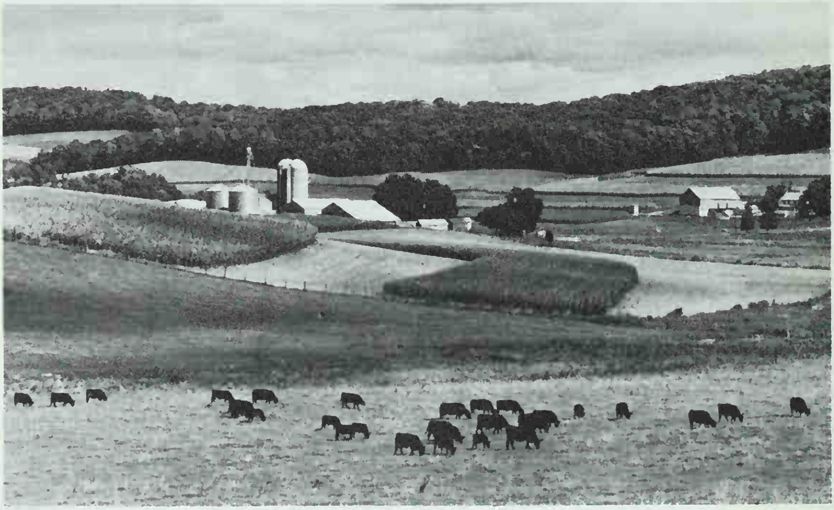
If you've traveled through farm country, you've seen stripcropping, windbreaks, and terracing that farmers use to protect their soil from erosion.

There's much more you don't see. A lot of conservation practices seem to be a natural part of the landscape. Conservation tillage, proper grazing use, wildlife habitat management, and irrigation water management all control erosion, but you might need a conservation specialist to show them to you and explain how they work.

It's part of the pleasure of being a farmer or rancher—living on the land, producing food and fiber for people, and leaving the land in better condition than it was.

When farmers and ranchers

Protecting America's soil and water resources is a concern everyone should share. (George L. Green, SCS, ORE-75,373)



Alternating strips of corn and small grain help protect a Maryland farm from soil erosion. (Tim McCabe, SCS, MD-30,620) improve their own land, they also often improve the land around them. For instance, when they control erosion, they're also helping to keep sediment out of streams and rivers, thus reducing the cost of government by alleviating the need for roadside maintenance, dredging, water treatment, and flood damage.

Brush Control. . .and Water Yield

Five ranchers started working together back in the early 1960's to return their rangeland in West Texas to a natural grassland cover by controlling brush and carrying out sound range management. Through rootplowing, treedozing, aerial spraying, chaining, reseeding, and grazing management, they reduced the excess brush cover—mainly mesquite—and improved forage production, wildlife habitat, and watershed capabilities on thousands of acres.

Within a year or two, the ranchers noticed that freshwater springs on their land that had been dry since the thirties were starting to flow again. Then, in 1970, the springs brought back to life a creek—West Rocky Creek. Today, that creek is an important new source of water for the city of San Angelo. (The article "The Creek That Slumbered 40 Years" describes this regeneration.)

The reason for the recovery of the springs and the creek goes back to the brush control and grazing management. Brush—especially mesquite—uses several times more water than the native grasses in the area do to produce the same amount of plant material. By controlling the brush, the ranchers had conserved water normally consumed by the brush—so much water that the aquifer was recharged and the springs started flowing again.

Their conservation work was a joint effort—not uncommon in soil and water conservation activities—and it had offsite benefits worth millions of dollars, improving the environmental, economic, and social well-being of their rural and urban neighbors.

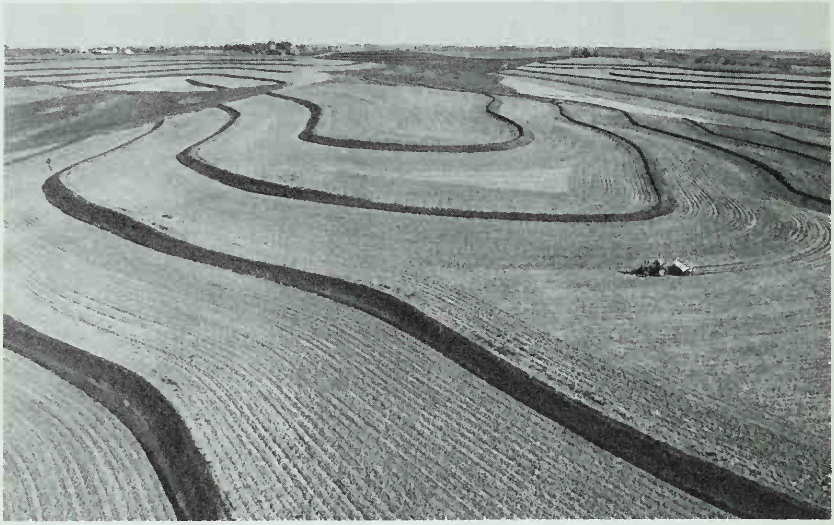
A Proud Tradition

Fifty years ago farmers and ranchers got together to develop local soil conservation districts. Through districts in nearly every county, they have a proud history of encouraging soil and water conservation activities.

They've provided leadership that's made a big difference in almost all of our lives. They've tried out and encouraged new ways of protecting the land, such as conservation tillage for reducing the amount of tillage—and erosion—on cropland.

They've bought and loaned equipment to encourage conservation. They've identified local problems—like roadside erosion and erosion at construction sites—and taken steps to control it. They've encouraged youth groups to take on conservation projects and provided them with assistance.

More than 2 million farmers and ranchers are working through conservation districts to improve soil and water conditions on non-Federal lands.



An Iowa farmer uses conservation tillage, terracing, and other conservation practices to protect the soil from eroding. (Tim McCabe, SCS, IA-2865)

Contact your local conservation district, if you haven't done so, and see how you can improve your land. . . and help others improve theirs. You might want to take an even more active role—serving on the district board. As a district director, you would be helping to identify and solve soil and water conservation problems in your area.

Conservation on the Job

There's no telling what you can do when you include an interest in conservation in your job. Some years ago a University of Texas employee was concerned about the condition of public lands the university controlled. He sought support from many people. . . and he got it. As a result of their efforts, 2 million acres have been improved through conservation planning.

The sharp eyes of a Penn State University employee helped bring about the introduction of a conservation plant used in the East for roadbank stabilization.

He noticed the plant on a farm—no one knows how it got there. The plant caught his attention for its attractiveness and its ability to stabilize the soil from erosion. He gathered some seed and pursued his interest in it as a conservation plant. The result: the conservation plant known as ''Penngift'' crownvetch.

In the Community

You can make an impact on the land through many community groups. You can sponsor studies, take on projects, work with young people, identify soil and water conservation problems and find ways to take care of them.

Increasingly, local, State, and Federal agencies are offering a wealth of opportunities to volunteers. Award-winning conservation district newsletters are produced by volunteers. Young people get firsthand experience in natural resource careers, and retirees start new "careers" in a field in which they've had a longtime interest.

Bringing People Closer Together

There's something about working on the land that transcends a lot of our differences. Hugh Hammond Bennett, who founded the Soil Conservation Service more than 50 years ago and served as its first chief, once made this observation:

"Working on the land for so many years I have reached the opinion that we have missed something. We have had great statesmen and educators, writers and scientists from the beginning of time, and they have been telling us the right things to do, how to live, how to get along; they passed fine laws. But we seem to have made no advance whatsoever when it comes to getting along with one another the world over...

"But it seems to me when you get out on the land and work with people and talk with them about the productivity of the soil, there is some sort of common denominator there. You always come to some sort of understanding with one another...wherever and whenever you begin to talk about the fertility of soil and how it relates to the welfare of humanity, you are talking a common language. You are talking about a thing that brings people closer together. It will bring nations closer together."

Think Conservation

For the next week, sharpen your senses to conservation. Look at the farmland and ranchland around you. Is it eroding? Can you pick out some conservation practices on it? What shape are your schoolgrounds in? Your parks? Your roadsides?

Then, think about picking a personal project. Is there something demanding your attention? Has something been nagging at you for improvement? Maybe you've noticed eroding areas near your home. Maybe you've been thinking of forming a nature club for children or inviting some city children to your farm to help them understand how agriculture works. If you need some resource materials and information, get in touch with agencies in the U.S. Department of Agriculture.

Make some contacts. You can have a lot of fun. You can do a lot of good. And you will make a difference.

Technology Improves Tillage and Soil Treatment

T.J. Army,
deputy administrator,
Agricultural Research Service

Agricultural technology has been changing since human beings first herded animals or planted seeds. A few centuries ago the culture of crops became synonymous with clean tillage—turning the soil over to a depth of several inches, burying the residues of the previous crop, and pulverizing the soil surface to make it smooth and granular. Until recently, clean tillage was the only way a farmer could control weeds. Invention of the moldboard plow in the last century reduced energy requirements and increased the efficiency of clean tillage.

Then early in this century the replacement of animal with machine power reduced labor requirements and made it possible for one person to farm much larger acreages. Introduction of hybridization and other breeding techniques resulted in higher crop yields that increased productivity potential for a unit of land area and, thus, the potential productivity of individual farmers.

Use of chemical fertilizers increased that potential even further, eliminating the need to maintain livestock to produce manure for fertilizer. Development of effective pest control chemicals has now greatly reduced the risks of crop management. As a result, farmers have become crop specialists abandoning crop rotations and concentrating on continuous production of one or two crops, especially cotton, small grains, corn, and soybeans in the South and Midwest.

Clean Tillage—The Traditional Way

In the 1960's and early 1970's large areas of U.S. farmland, whether irrigated or not, were clean-tilled and under some type of monoculture—continuous corn year after year, for example. Problems with land and water resources, such as excessive erosion, salinity, and contamination increased while farms got larger and yields got higher.

The soil surface of a clean-tilled field is unprotected from the time of tillage until the establishment of plant

Following heavy spring rains, runoff carries sediment from crop fields into nearby roads and waterways. (Tim McCabe, SCS, TN-1124)

cover—which may be relatively scanty even in fully grown row crops. While unprotected, the soil surface is vulnerable to wind and water erosion made even worse by its granular state, with loose particles ready to be picked up and moved by wind or water.

In humid areas, the impact of raindrops soon converts the granular state of a freshly tilled soil surface to a relatively compacted crust. This crust helps the soil resist wind erosion, but it reduces the infiltration of water. Reduced infiltration not only deprives the growing crop of moisture, but also increases runoff. Increased runoff leads to increased rill and gully erosion and to subsequent pollution of streams and rivers with silt and clay, often at great distances from a particular farmer's field.

The interior of a soil is a complex ecosystem of minerals, air, water, and living and dead plant and animal organisms. When soil is turned over with a plow and pulverized with a disc during conventional clean tillage, several things happen. The soil surface dries. Water evaporates and is lost for use by the subsequent crop. This can be critical in establishing a crop under semiarid conditions. Atmospheric air replenishes the air within the tilled soil. Surface residues are buried. The sun beating on a bare soil surface raises soil temperature. When oxygen level and temperature are higher, organic matter in the soil oxidizes more rapidly. The soil microorganisms that mineralize the nutrients needed for high-yielding crops are most active in warm, moist soils containing plenty of organic matter.

So, clean tillage usually results in a period of rapid organic activity immediately following tillage, followed by a prolonged period of greatly reduced activity for the rest of the growing season. Continuous clean tillage also is detrimental to larger soil organisms—earthworms, for example, are less populous. It usually results in low organic matter content, which leads to lower infiltration rates and reduced water storage capacity.

Use of Larger Machinery

The popularity of large-scale monoculture led to the development of larger and heavier machinery. Early tractors, for example, weighed about 3 tons. They compacted soil mainly within the depth of soil that could be broken by plowing. Today's large 4-wheel drive tractors and the equipment they pull may weigh 50 tons. They compact soil as deep as 2 feet. Compaction at such a depth cannot be economically broken up by machinery, nor will natural weathering relieve such compaction within only 1 year. This compaction hinders root development at depths greater than 6 to 10 inches, so that nutrients and water beyond those depths are often not readily available to crops.

Large self-propelled machinery also is used for harvesting. Increased machinery size has increased field size and, in many instances, removed erosion control measures such as terraces and shelterbelts. This urge to save time may result in tilling through grassed waterways. Bigness and increased efficiency do not always translate into improved protection for land resources.

Conservation Tillage—An Alternative

As American agriculture moved toward monoculture and larger farms, some agriculturalists realized that the country's soil resource was being degraded. Researchers had been searching for ways to grow crops without plowing since the early 1930's. Large- scale experiments with sweep tillage were conducted throughout the Great Plains in the early 1950's with the slogan, "Keep the Stubble on the Surface." The development of weed control chemicals made it possible in the early 1960's to intensively explore reduced tillage methods. These methods and techniques usually resulted in leaving some of the residues from previous crops and ground cover on the surface. Such residues protect against erosion. Reduced tillage in all its ramifications and with various types of equipment has come to be called "conservation tillage."

Farmer interest in conservation tillage was greatly stimulated by the fuel crisis and inflation of the 1970's. Reduced tillage required less labor and less energy than clean tillage. The cash-flow crisis of the mid-1980's broadened interest even more as farmers seek to minimize operation costs.

Relationship With Soil. Crop residues left on the surface serve as thermal insulators. Consequently, compared to plowing, reduced and no-tilled soils have lower spring and summer soil temperatures. This results in less evaporation; hence, minimum-tilled soils are generally more moist than plowed soils.

Minimum incorporation of crop residues also affects the availability of foodstuffs for microbial activity within the soil. Crop residues on the soil surface, compared to those buried in the soil, are drier and decompose more slowly. Thus, microbial activity is relatively constant during the growing season, allowing for more uniform release of nitrogen in crop-available forms. This increases nitrogen use efficiency. Crop residues left on the soil

As barley is harvested, a Maryland farmer plants soybeans in the barley stubble. By using conservation tillage in a double cropping system, the farmer is protecting the soil from erosion as well as saving time and fuel. (Tim McCabe, SCS, MD-30,616)

surface also attract higher populations of surface-feeding earthworms. The worm holes act as drains, diverting the water into the soil rather than allowing it to run off and carry soil away during heavy rains.

Relationship With Crop Production. Some conservation tillage systems now include crop rotations. Cropping systems that contain legumes often retain more soil organic matter, increase infiltration rates and nitrogen availability, and reduce soil erosion. Use of cover crops and intercropping may be especially advantageous in reducing runoff and erosion, groundwater pollution, and need for higher rates of fertilizer nitrogen.

In dry regions, the increased moisture conservation and erosion control are particularly valuable. The northern Great Plains receives considerable snow each winter, but on bare fields, it blows off. Standing stubble left by conservation tillage traps the snow in place on a field, and melt water eventually infiltrates. This maintenance of standing residues through the winter has made annual cropping possible. Conventional crop-fallow rotation is rapidly disappearing except in the extremely rainfall-deficient areas. The fallow year is not just a year of lost production. In addition, vegetation must be kept in check so as not to exhaust the soil moisture, and a farmer who is conscientious in minimizing wind erosion expends considerable labor and machinery costs in keeping the soil surface roughened.

Perhaps more important in the long

Corn residue in a Nebraska field protects the land from erosion and retains moisture for the next crop. (Gene Alexander, SCS, NE-2256)

run is the effect of the increased residue production and nearly continuous protection afforded the soil by annual cropping. Limited tillage or no-till cropping systems become progressively more beneficial with time, in terms of physical and chemical properties of dryland soils.

Benefits to Irrigated Cropland

In the central and southern Great Plains, conservation tillage provides better wind erosion control and, more importantly, conserves scarce groundwater resources. Conservation tillage practices reduce evaporation from soil surfaces and can keep soils sufficiently moist to allow seedling establishment without irrigation. This can reduce the use of pumped water from one-third to one-half.

Crop production in the Central Valley of California and other arid regions of the West is entirely dependent on irrigation. Arid soils are often high in salts, and farmers must apply more water than the crops actually need to leach these damaging salts from the soil. The saline water draining from these soils has traditionally drained to low spots in the landscape, and wildlife areas have developed around them. Micronutrients, some of which are toxic at high concentrations, have become so concentrated in some areas that the continued use by wildlife is threatened. Recent introduction of automated drip and sprinkler irrigation technology is leading to greater control over drainage, reducing the quantities of drain waters to be managed. The arid West contains about 57 million acres of salt-damaged irrigated lands.

Technology Ever Changing

The impact of technology on agriculture and our land resources is an ever-changing phenomenon. It is nearly impossible to describe it in all its complexity—indeed, it is impossible to understand it fully. However, scientists, farmers, ranchers, and other concerned individuals will continue to evaluate it and find new ways to ensure that our valued land and water resources are productive and maintained for future generations.

Technology Unlocks Cropland Productivity

C.W. Carlson,
retired as Acting Assistant Administrator,
Agricultural Research Service

The success story of American agriculture is the envy of the world. Between 1950 and 1980 total U.S. crop production doubled with a 5-percent increase in cropland and a 63-percent reduction in labor use. U.S. farmers were so productive that agricultural policies were dominated by farm surplus problems.

After World War II, rapid development and application of such yield-increasing technologies as fertilizer formulation and delivery, plant variety improvements, moisture conservation, and irrigation occurred. The impact of these technologies on the Nation's food and fiber production, however, peaked in the mid-1970's.

Concern About Land Base

In the late 1970's, increasing energy prices, a declining rate of productivity growth, and losses of farmland to nonagricultural uses caused some to question if U.S. farmers would have enough land to produce the food and fiber needed to satisfy domestic needs and rising demand for agricultural exports.

Another group believed that natural resources were inexhaustible. In the early 1950's, a prominent economist, Theodore W. Schultz, questioned the importance of agricultural land in modern agriculture. During the past four decades, the Nation vacillated about how much cropland was needed. During most of the period, crop surpluses caused many to argue the base was too large. But grain shortages in the 1970's caused immediate concern about the adequacy of U.S. cropland.

While much is made of nonfarm demands for land, this need claims only a small portion of the Nation's land area. Earl O. Heady estimates that, if present trends in conversion to nonfarm uses of land continue, by the year 2000 urban uses will absorb less than 2 percent of the total U.S. land area. The most vigorous public opposition to nonagricultural uses of land comes from the States that produce a modest fraction of the Nation's total agricultural production (Maryland, New Jersey, New York, and Oregon). The States that contribute most to our agricultural production show little concern for farmland conversion to urban uses. Attempts to curtail the conversion have failed. Because the value of

Center-pivot irrigation systems help conserve land by bringing higher yields to farmland already in production. (USDA, 0983X1212-26)

land for urban uses exceeds that for agricultural production by more than tenfold, reversing the trend is difficult.

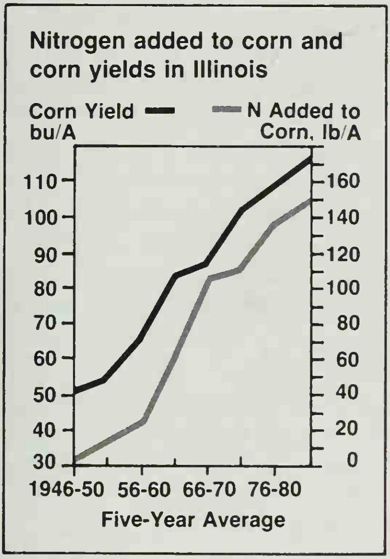
Technology as a Substitute for Land

Fertilizer, irrigation, moisture conservation, new varieties, and pesticides all increase crop yields. When these are combined into a system, the increase is even greater than when they are used individually. Increased yields have affected how much land is needed for food and fiber production. In 1910, for example, U.S. farmers produced 120 million tons of grain on 192 million acres of land; in 1979 they produced 216 million tons on 162 million acres. The 7.6-billion-bushel corn crop produced in 1979 on 69 million acres would have required 272 million acres at the 1910 yield levels.

Fertilizers. The amounts of fertilizer used in the United States were quite small until World War II, but usage increased greatly after 1945. Because soils are most deficient in nitrogen for agricultural needs, several researchers have assessed nitrogen's impact on the yields of the important grain crops. L.F. Welch relates corn yield increases in Illinois over the last 35 years to nitrogen use. Average corn yields doubled when 150 pounds of nitrogen an acre a year was added. Welch emphasizes that these increases were not due to nitrogen alone. Improved hybrids, better cultural practices, and adequate phosphorus and potassium also were important. But lack of added nitrogen would have reduced the effect of other factors significantly.

To determine how much less land was needed when nitrogen fertilizer was used, researchers in Kansas and Iowa assessed the substitution and found that a ton of nitrogen fertilizer replaced 24.3 and 16.1 acres of land, respectively, at the irrigated Kansas and dryland Iowa locations. In studies to determine how much typical fertilizer levels in developing countries substituted for land, results showed that a ton of fertilizer applied to rice substituted for 29 and 54 acres of land in Thailand and Peru, respectively. With wheat, a ton of fertilizer substituted for 11 acres in Argentina and 24 in Chile. The substitution rates varied because of technology levels in these countries as well as climatic differences.

Irrigation Irrigation is a land-conserving technology not only giving



higher yields but also reducing the losses from the vagaries of weather. Irrigation adds to the cropland base. Development of center-pivot irrigation, for example, made it possible to produce green crops and potatoes on sandy soils in Nebraska and Oregon that had supported little production when dryland farmed.

High value specialty crops are grown almost exclusively on some irrigated lands. More than 25 percent of the crop value is produced on about 61 million acres of irrigated lands (16 percent of U.S. cropland). Nearly 83 percent of the irrigation is in the West, where it is essential to productive agriculture.

Expansion of irrigation has not been caused by pressures on the agricultural land base. Since 1950, the irrigated acreage has doubled even though Government programs have been designed to reduce crop acreage.

Advances in engines and pumping equipment and widespread droughts in the 1930's resulted in a large expansion of irrigation in the Great Plains States between 1940 and 1970. This area has accounted for 60 percent of the growth in western irrigation since 1950. Eighty percent of the water used comes from ground-water aquifers. This expansion has depleted the ground water. The mining of underlying aquifers has forced some farmers to return to dryland farming.

Use of irrigation in the East has grown much faster than in the West in recent years. Acreage under irrigation has doubled in the Southeastern States, especially because of accessible ground and surface water and improved irrigation equipment.

Probably the biggest incentive for irrigation development in the Southeast has been double cropping of soybeans and wheat. Farmers can now harvest two crops in the same year. Also, in recent years livestock farmers have irrigated more feed grain and forage crops to ensure that feedstocks are available during drought years. The total irrigated acres in the East now exceed 5 million. Experts predict a 3-percent annual growth rate in irrigation over the next two decades.

In the West, however, the days of plentiful cheap water are over. A declining ground-water supply along with urban demands for water and environmental concerns makes it difficult to increase irrigation. Regardless of what happens to crop prices, irrigation cannot be expected to contribute

An ARS biological aide checks the depth of water conserved with a level terrace system. Terraces reduce erosion on dryland farms and allow storm water to soak into the soil instead of running off the land. (ARS, 0686X703-27)

as much to agricultural expansion as it has in the past.

Moisture Conservation The Great Plains makes up about one-fifth of the U.S. land area. It has distinct climatic advantages such as high-intensity solar radiation, few cloudy days, and low humidity, which makes the region well suited for crops like wheat and grain sorghum.

Drought is the most serious climatic hazard. Adequate rainfall in the 1880's made it possible for those settling the area to produce good crops. However, the drought in the 1890's forced many of the settlers to move on. The great migration came in the 1930's when a severe drought coincided with a national economic depression.

Starting in 1915, much research and dissemination of information has been directed to conserving the limited rainfall of the area. Every inch of water that cultural practices and tillage systems can conserve results in increased wheat and grain sorghum yields. These systems used with improved wheat and sorghum varieties resulted in more grain per inch of water used by the plant.

The technology developed through research and the practical experience of perceptive farmers has turned the area once called the ''great American desert'' into the ''great American granary.'' The risk of crop failure from drought once so common to the area has been substantially reduced.

Integrated Production Systems. American farmers have long recognized that the payoffs are great when new technology can be incorporated into a crop production system. Even though it took 30 years to develop a production system for hybrid corn, the payoff made it worth the effort. In the early 1980's, the British developed a system for producing more than 100 bushels of wheat an acre. This system, now used in several European countries, is responsible in part for the high wheat and barley production in these countries.

In 1985, wheat farmers adapted this system in Arkansas. It has components such as high-yielding hybrid seed, fertilizer, pesticides, and growth regulators, which made it possible to obtain wheat yields approaching 100 bushels an acre. Wheat growers in

An ARS scientist examines wheat plants in a test plot. (ARS, 1085X1143-11A) several other Eastern States are working on systems to give them yields in excess of 100 bushels an acre.

Fewer Cropland Acres Needed

U.S. farmers are more export-dependent today than they have ever been. The domestic demand for farm products is about half what the United States is capable of producing. The available improved farm technology around the world has caused a world overproduction crisis. Until the 1960's, few countries outside the United States experienced rising crop yields. Today record crop yields are occurring annually in all of the grain-producing countries.

If agricultural research continues to receive adequate support from the public and private sector, needed food and fiber will be produced on fewer acres. There is little reason for concern that the United States will run out of farmland.

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Credits

The people who worked to create this book, besides the authors, include:

The 1987 Yearbook Executive Committee which developed the list of subjects and searched out and solicited articles from the most appropriate authors.

Robert R. Shaw, Soil Conservation Service, chairman.
William Anderson, Economic Research Service.
John L. Artz, Extension Service.
Thomas L. Browning, Agricultural Stabilization and Conservation Service.
Douglas Helms, Soil Conservation Service.
James R. McMullen, Agricultural Stabilization and Conservation Service.
Neill W. Schaller, Economic Research Service.
Dwight M. Treadway, Soil Conservation Service.
David J. Unger, Forest Service.
Edmund J. Vandermillen, Forest Service.

Others who contributed to the work of the Executive Committee are George Castillo, Kenneth N. Larson, and Dennis M. Roth, all with the Forest Service.

All named below are in the Office of Information, Office of Governmental and Public Affairs.

Art Director: *George Baka,* Design Division
Chief Designer: *Eva D. Cuevas,* Design Division
Cover Designer: *Janice M. Proctor,* Design Division
Photo Editor: *June Davidek,* Photography Division
Text Editor: *Grace I. Krumwiede,* consultant to the Special Programs Division
Printing Coordinator: *Warren Bell,* Printing Branch, Publishing Division

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